ANNALS
OF
SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

EDITED BY
LEWIS STEPHEN PILCHER, M.D., LL.D.,
OF NEW YORK

WITH THE COLLABORATION OF

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NOTES ON SERVICE IN THE FRENCH ARMY MEDICAL CORPS

BY CARROLL CHASE, M.D.

OF BROOKLYN, NEW YORK

MÉDECIN AIDE MAJOR DE 2e CLASSE DE L'ARMÉE FRANÇAISE

IT should be stated at the outset that this paper makes no pretence of being a scientific compilation of statistics. It would be presumptuous for me to attempt such a thing with the comparatively limited experience I have had. The French are keeping remarkably detailed histories of each wound, with the ultimate result that the question of pensions after the war will be made much easier and, of far greater importance to the world at large, that immensely valuable statistics of wounds, their treatment, progress and results will be available. In fact, much has already been written.

Rather let me attempt to give some idea of the routine work and experiences that come to a Médecin Aide Major in the French Army, this rank corresponding to the rank of Lieutenant in the United States Army Medical Corps. My service so far has covered a period of some seven months only. As soon as given my appointment I was assigned to the Fifth Region, of which Orléans is the headquarters. The first month I was attached to three different hospitals in that city to give me a chance to learn the ropes a bit before I was given a surgical service of my own. Here I assisted at operations and dressings and began to get an idea of the ordinary routine treatment of war wounds. Dr. Lenormant was "Surgeon of the Sector" here, and I had the pleasure of seeing, and occasionally assisting, with his work. His technic was clean-cut and his manual skill quite evident.

After a month here I was sent to Melun, a city of some fourteen thousand, also in the Fifth Region, on the main line of the P. L. M., forty-five kilometres (an hour by train) south of Paris. There were six military hospitals in the city, including the "Hôpital Mixte," or civil hospital, now "mixed" because it took care of both civil and military cases. I was assigned to "Hôpital Militaire No. 12," which had 266 beds. Excepting "Hôpital Mixte" this was the largest hospital in the town. It occupies about one-half of the College Jacques Amyot—a good-sized building, corresponding somewhat with a boy's preparatory school, such as is found near all large cities in this country. Each hospital had from

one to three medical officers attached to it, No. 12 having three: The "Médecin-Chef," who was the executive medical officer commanding, another "Médecin Aide Major" (not a surgeon), and myself.

It should be remembered that the French make a clear-cut distinction between physicians and surgeons. Of the latter there were only two others beside myself for the six hospitals, and one of these two, Dr. Rocher, Professor of Surgery at Bordeaux, was "Surgeon of the Sector," and was responsible for all surgical work at Fontainebleau, a few miles away, as well as at Melun.

It might be stated that throughout France various buildings are now used for hospitals. The town hospital always, next most common are schools, then convents, barracks, etc.

These figures, of course, are not official, but I am told that there were approximately 20,000 doctors in France when the war broke out, that of these about 14,000 have been mobilized, and that of the latter, some 1500 have been killed or seriously disabled. Before the war there had been seven doctors at Melun, but six had been mobilized, leaving but one civilian physician, not a surgeon, in town. This meant that the military surgeons had all the surgical work at Melun, including the civil surgery at Hôpital Mixte. The operating, because of the arrangement of operating rooms, X-ray apparatus, etc., was done at only four of the hospitals, the wounded being moved from one hospital to another as became necessary.

In addition to the hospital work already mentioned, the medical care of the troops in training, etc., at the various barracks in the town, the Gendarmes, the German prisoners of war working on the farms close by, as well as the emergency work among the population, including the Belgian and French refugees, that the lone civil practitioner left in the town could not get in, all fell to the medical officers attached to the various hospitals and was divided among them. A certain amount of this work fell to me, and I had civil cases from time to time ranging from pulmonary hemorrhage, ruptured varicose veins and tetanus, to infected fingers and miscarriages.

The food at the hospital was excellent. The man who was chef when I first arrived had been chef at the Café Royale in London when the war broke out. He brought all of his skill with him and the wounded received the benefit. Breakfast ordinarily consisted only of bread and coffee, but the lunch and dinner were hearty, well-cooked and well-served. A large tin cup of red wine went with each meal except breakfast. Special diet was provided whenever ordered. The officers had a bit more variety than the men and it was served in a little more dainty fashion. Before I left every man of the entire kitchen force had been sent to his regiment and replaced by a woman, but the service did not deteriorate.

I stayed at this hospital, No. 12, until my return to the United States on furlough. As a service rarely lasts longer than six months without a change of location, I would have been transferred elsewhere very soon,

had I remained. There was a constant change of personnel while I was at Melun, only two medical officers that had been there when I arrived still being there when I left.

Medical officers at the front, that is, in the "zone of the army," have seven days' "permission," or furlough, every three months, the time spent in travel to and from the destination not being counted. In the interior we have seven days every four months and in addition one day each month. This gives no great chance to visit hospitals in other cities, but I managed to see the American Ambulance at Neuilly, and Dr. Blake's hospital at Ris Orangis, as well as Dr. Carrel's hospital at Compiègne, and I was fortunate to spend my seven days' "permission" in London, where I particularly enjoyed my visit to the Radium Institute. An occasional "permission" for the afternoon is also obtainable when the work allows, and this gives an opportunity of running in to Paris from a town as near by as Melun.

Except for a hospital some miles out of town where eye injuries were treated, no special cases, such as eye, ear, throat and nose wounds, lower jaw fractures, nervous diseases, bad burns, etc., came to Melun. We also had no sick except such as came from the barracks and the neighborhood. The wounded were all French, the one exception being an Australian, who had stuck his head too far out of a car window while a troop train was passing through our town. He had a badly fractured skull, but finally pulled around.

Our patients arrived by the sanitary trains that are designed for carrying the wounded all over France. They are complete, with operating room, dressing room, facilities for cooking, and quarters for the officers and men in charge. One of the finest is that under the auspices of the American Ambulance. The system used is most efficient. The patient stays on the same stretcher from the time he leaves the front until he arrives at the hospital of his destination. We would receive a telephone call at, say, 9.30 A.M. that a train of wounded would stop at Melun at 11.45 A.M., and discharge forty-two severely wounded and thirty sitting patients. The train would roll in about on time, and, once when I timed them, in ninety seconds after the train stopped wounded were being unloaded. We had four ambulances in Melun, three autos and one horse-drawn vehicle. These were used for distributing the wounded as rapidly as possible. The Surgeon of the Sector, when present, or, if he were away, the surgeon next in point of seniority, made the assignments of the wounded to the various hospitals.

Typical French military hospitals, such as we had at Melun, are quite different from hospitals such as the American Ambulance, Dr. Blake's hospital, or even Dr. Carrel's hospital. Our Surgeon of the Sector, Dr. Rocher, after visiting at Dr. Blake's, made the remark that the surgery done there wasn't war surgery but was "surgery de luxe." I think this gives a very fair idea of the difference. Dr. Blake's operating room—in fact the whole hospital—compares favorably with the hospitals here in

New York City. At Melun we had not much more than the bare necessities, but we lacked no real essentials. We certainly had no frills. Our dressings were packed and sterilized in Huntley and Palmer biscuit tins, but that is no reason why they were not as sterile as if packed in Dr. Blake's nickel-plated containers. We had X-ray laboratories in only two hospitals, but it was easy enough to move such wounded as needed X-ray diagnosis to one of them, or to carry them there and back in an ambulance for the examination. If we didn't have a full range of instruments at one hospital, it was easy enough to borrow from another, and I have no recollection of ever having lacked an essential instrument. The operating tables at Hospital 12 were solid wooden benches, but at No. 20, for example, we had a table which allowed Trendelenburg.

As regards nurses and nursing: One hospital, No. 6, was under the auspices of the French Red Cross, and had several young women, including a couple of professional nurses, all of whom lived at the hospital. Just incidentally, this hospital was not particularly popular with the wounded, because the rules of conduct there were more severe—no card-playing for sous, for example. Can you imagine the average French soldier playing cards for glory only? Hospital 20 had four or five semi-professional female nurses, who were at the hospital all of each day, and of course "Hôpital Mixte" had a few resident nurses. At my hospital, No. 12, we had about fifteen orderlies, all soldiers of the French Army. These men lived at the hospital, but before I left their places were being taken by women. The two orderlies who were to be retained were considered indispensable, one having charge of the operating room and its supplies, and the other being skilled in massage. In addition to the orderlies we had six or seven women of culture and refinement who lived in Melun, who came to the hospital daily to assist with, and in fact do, most of the dressings, and also assist in the operating room. Their patience, gentleness, faithfulness and excellent judgment, and their skill in doing surgical dressings cannot be too highly praised. Having done this work daily since soon after the war began, the old adage that "practice makes perfect" is well exemplified.

Pharmacists and chemists have ranks as officers in the Medical Corps corresponding with those of doctors. One is assigned to each of the larger hospitals, or perhaps to two of the smaller ones. He is responsible for the preparation of all prescriptions and solutions—Dakin's, for example—as well as for all analyses of wine, milk and other foods used in the hospitals. The chemist assigned to my particular hospital was a well-known expert on poisonous gases, and I spent many an interesting hour in his laboratory, sometimes getting a sore nose and throat for my pains. The idea of giving the pharmacists commissions seems to work out to good advantage, and is worthy of consideration in this country.

None of the medical officers live at the hospitals. Each finds a room in the neighborhood. Mine, for example, cost me a franc a day, and was

as clean and neat and comfortable as could be wished, except that it had no heat. We get our meals at one of the smaller hotels or with a private family. I ate lunch and dinner with a group of officers at the Hôtel du Grand Turco. Six or eight of us had a private dining room and paid 2 francs, 25 centimes (about forty-five cents) per meal. Considering war prices, this was most reasonable, for the food was good, and cooked and served in the usual excellent French manner. Such days as we had time, a round of bridge after meals served to relieve the monotony of our work.

Perhaps a typical day's work at the hospital would be about as follows: We all arrived at eight o'clock. The medical staff, with the military officer in command of the hospital (who attends to purchasing and supervising the preparation of food, paying the soldiers, etc.), first make the rounds of the hospital. Every wounded or sick man is seen, and the entire hospital is visited. The food is examined, and care is taken to see that everything is shipshape. After this the surgical dressings are done, invariably in dressing rooms fitted for the purpose, except when it is dangerous or too painful to move the wounded man from his cot. There were three divisions and three dressing rooms at Hospital 12, each of the medical officers looking after the dressings on one of the three floors, although, as surgeon, I was called to see anything out of the ordinary. The dressings, if not finished by noon, were continued after lunch. X-ray examinations at "Hôpital Mixte," or No. 20, perhaps took up part of the afternoon, while the making out of reports, etc., filled the balance of the time before dinner. It was usually late when dinner was finished and bed was welcome at a reasonable hour. Of course operations from two or three to five or six days a week interfere with this schedule. Not infrequently, when the wounded were arriving twice a week, the entire day would be spent in the operating room.

The giving of anæsthetics usually fell to a nurse or orderly, and frequently was poorly done. For general anæsthesia chloroform commonly was the choice, ether very rarely being used. Chloride of ethyl was used as a general anæsthetic for very short operations, such as the opening of abscesses. Spinal anæsthesia with novocaine or stovaine was a favorite with Dr. Rocher, and with one or two exceptions it was well borne. For local anæsthesia, ethyl chloride or cocaine was usually employed. Occasionally, when a particularly long operation was to be done, or when the wounded man had a bad heart or was not in good general condition, one of the surgeons gave the anæsthetic.

In some respects the operative technic varies considerably from American methods. The use of thick rubber gloves with short fingers and long wrists is almost universal, and it was not long before I became used to them, and now I am rather sorry to be obliged to go back to the thin tight gloves. The thick gloves are much more comfortable and of course are not easily punctured, and the tactile sense is not nearly so much interfered with as one might expect. I never saw a needle holder

in a French hospital. The Reverdin or Doyen needle (corresponding to our perineal needle) is always used, except for special work, such as nerve suturing. These two styles of needles are similar, but one is arranged to thread by opening the eye of the needle by moving a thumb attachment in the handle. An ordinary sewing needle with fine linen or silk thread was used to suture nerves and while using this it was customary to put on a thimble over the glove. Plain catgut and silkworm gut are the common ligature and suture materials. The latter is always dyed a brilliant color. Unabsorbable buried sutures are rarely used except for nerve or intestinal work. Chromicized catgut I never saw. Clips are often used for the skin. Hand sterilization consists of gentle brushing with sterile soap and a sterile brush in a basin of sterile water for six or eight minutes. The hands are then dried on a sterile towel and after rinsing with ether are soaked thoroughly in 95 per cent. alcohol to which has been added a little iodine, just enough to stain the hands yellow. Frequent hand preparation by this method did not affect the usual smoothness of the skin.

I think the one point in the technic that I would be most inclined to criticize is that ligatures and sutures are often tied too tightly. Small gauze sponges are never used, compresses taking their places. Whenever possible the operator and his assistants sit down on stools of the proper height. When it is necessary to spend the entire day in the operating room, this makes quite a difference. Patients are tied on the operating table, and one never sees the surgeon leaning on one leg with an assistant holding the other, while nurses try to keep the rest of the patient on the table.

The preparation of the field of operation consists of thoroughly washing with soap and water and shaving, some hours before the operation. No dressing is then used unless it be perhaps ordinary bandaging. After anæsthesia is complete, the entire field is painted dark brown with tincture of iodine. If discharge is present, it is washed away with ether before the iodine is applied. For quick sterilization of clean instruments and basins, flaming, either with a Bunsen burner or with the aid of 95 per cent. alcohol set on fire, is much used. At Dr. Carrel's hospital I saw plans for a heated operating table, ordinary incandescent lamps being used for the purpose. He also had plans for a heated cover for an operating table. Both of these are meant to prevent the undue loss of body heat and to combat shock, and seem quite practical. While operating all X-ray pictures of the case are pinned up in a window where they can be seen at a glance.

The great majority of wounds are from fragments of shell. Bullet wounds are next most common, while hand-grenade wounds, burns, and bayonet wounds follow in the order mentioned. Of the last named I saw but one case. Multiple wounds are the rule. A single wound from a shell fragment is exceptional. Thirty, forty or fifty wounds from the

explosion of a shell close by are not particularly rare. I remember the case of a stretcher-bearer who was helping to carry a wounded officer near Verdun. A German shell of good size exploded close by, killing the wounded officer, the other stretcher-bearer and two medical officers who were walking with them. The man who escaped with his life came to the hospital literally covered with wounds on one-half of his body; there were well over a hundred. We picked out pieces of shell, clothing, newspaper and gravel at each dressing for days afterwards. He was suffering pretty severely from shell shock and was almost entirely deaf when he was admitted, but he had no one serious wound. An abscess in the cheek on the opposite side was a puzzling complication, until it was figured out that he had had his mouth open when the shell exploded and a piece of gravel had entered the cheek through his mouth. Inside of a month he was ready for the furlough which is granted all seriously wounded men before they return to the front.

" Shell shock " was often seen in soldiers who were wounded by a shell that exploded close to them. I am told that this kills instantly in some cases, dead being found without any external wound. It varies in degree, of course, but the average case clears up in a few days and evidently leaves no bad results. Deafness, with or without the shell shock, usually clears up as promptly.

The two great bugbears for the surgeons are secondary hemorrhage and secondary infection. Judging from what I have been told by various surgeons we were fortunate in having less than an average share of the former. These hemorrhages may occur in a wound or at some distance from it. If a large vessel is eaten through, death often occurs before anything can be done. There seem to be two factors in its etiology: One—and the most important—is infection, but the trauma, apart from the infection, seems often to weaken the blood-vessel wall. The distance along which the artery may be affected is often surprising. The first hemorrhage of this kind that I tried to stop was from the radial artery, and the bleeding point was about an inch and one-half from the wrist. I followed that vessel up nearly to the brachial before I could find a portion sufficiently strong to bear a ligature. I found afterwards that this experience was not particularly uncommon.

Secondary infection is extremely common. Practically every wound that we saw was infected before it reached our hospital, and this is the same almost throughout France. With one or more infected wounds, perhaps not draining as freely as they might from every angle and corner (although the attempt had always been made to open and clean them thoroughly as soon as they reached the ambulance), it is not difficult to understand how secondary infection may develop. A rise in temperature, not necessarily large, was usually the first sign. Pain was next, and other signs, as redness, swelling and tenderness in a new area, promptly followed. Early and free incision and good drainage is the only method of treatment, although occasionally—I can remember per-

haps four or five cases—a continuous hot saline bath with the proper posture would forestall operation. I have since thought that possibly these cases escaped operation because the new abscess broke into the old wound, rather than because of any direct resolution of the newly-infected area.

While speaking of secondary infection, it always appeared to me that the remote severe infections of various organs—acute nephritis, endocarditis, arthritis, appendicitis, etc.—were extremely rare considering the universal wound infection, forming a focus of infection, often severe and large in extent. I remember but two cases of acute nephritis. Appendicitis was less rare and I suppose may often have been due to hæmatogenous infection.

I saw but one case of tetanus while in France. This was an elderly civilian who had cut his hand with a hatchet and had neglected the wound. He died after a very brief illness. Every wounded soldier receives a dose of antitetanic serum as soon as possible after he is hit, and a second dose a few days later. I have seen some startling rashes and two or three cases of very high temperature (107½ degrees in one case) but no permanent ill results.

The most frequent operation was removal of shell fragments or other foreign bodies, and the next most common was the opening up of secondary infection, while the next in order of frequency was the operation for osteomyelitis. When long-continued infection included bony structure, as it often did, one of two conditions was frequently observed affecting the bone; either it softened and became spongy, indicating more or less decalcification, or excessive callus formed, which, on occasion, became extremely hard. The experience of the French surgeons teaches that the only cure consists in the free removal of the abnormal bone tissue. My first impression was that the work done often was too radical, but later I became convinced that this procedure was right.

A word regarding the removal of bullets, shell fragments and other foreign bodies: At first I was much surprised at the difficulty of these operations. The first and greatest obstacle was the finding of the foreign body. All kinds of schemes are used. The X-ray will show metallic bodies well, but even while operating directly under the rays it is often far from easy to locate the foreign body. The depth is not indicated without turning the affected part, and until we received an apparatus to use in a lighted room it was necessary alternately to lighten and darken the room. The method of taking radiographs in several positions and determining the exact location of the metallic body by means of various lines also aided, but one serious drawback remained—bits of gravel, clothing, or other non-metallic bodies were sometimes overlooked. The vibrator was the most useful aid for finding metallic fragments not too deeply embedded. This was simply an electromagnet arranged to act with a make-and-break current, causing the shell fragment to vibrate so that it could be located by the sense of touch. The

sense of hearing was employed by another apparatus. This was so arranged that when a tip, worn on the finger inside of the glove and connected to a battery, was brought near a metal fragment the ear piece buzzed. One great drawback with both of these latter methods was the annoyance caused by the necessity of removing metal instruments from the field of operation while they were in use. Another was that lead or brass foreign bodies did not indicate their presence, because not magnetic. We often said in jest that if some one would only invent an apparatus by which we could taste the foreign body we could use all of our senses, because sight, hearing, touch and sometimes even smell had been utilized. Another thing that seemed peculiar to me at first was the difficulty of removing shell fragments even after they were located. If they had rested in the tissue any length of time they were more or less embedded in scar tissue and had literally to be dissected out. When this occurred in the centre of the psoas muscle, for example, it meant a new wound of considerable size. Of course the moral of this is the prompt cleaning of all wounds, including the removal of all foreign bodies, and this is being done to a greater and greater extent in the hospitals close to the front line.

Many of the problems in surgery which came up for solution had numerous puzzling features—questions which no text-book could answer except in the most general way. For example: A soldier came into the hospital two weeks after he had been wounded by a shell that had exploded behind him. Besides several minor wounds he had one serious injury that included a ragged wound of the soft parts and a comminuted fracture of the ischium. Naturally he had not lain on his back since he had been wounded. We opened up the wound still more freely than had been done at the ambulance, removed several small pieces of bone, packed the wound lightly with gauze saturated in Dakin solution and arranged a hammock or sling so that he could lie on his back without pressure on the affected area. By the time he was ready to be sent further south the wound had healed to a considerable extent, but he had developed a cough and we feared he would become tubercular. As so often happened, I could not follow the case through, because room was needed in the hospital and the convalescent, or easily moved patients, had to be sent farther away from the front. Another case was a soldier who had been shot through the abdomen by a rifle bullet in August, 1914. He came into my hospital two years later, in fair condition except for a small ventral hernia and a small sinus over the hip, about three inches below the crest of the left ilium. Without warning his temperature jumped to 105°, and he had symptoms of beginning intestinal obstruction. Perhaps unwisely, I decided to delay operation and the temperature gradually fell. Forty-eight hours later, under local anæsthesia, I made an artificial anus at the site of the hernia just outside of the left rectus muscle. His temperature then rapidly fell to normal and we were able to do a further operation in the course of a couple of weeks. The sinus, before mentioned,

was found to connect with an abscess cavity holding three or four ounces and lying inside of the pelvis but outside of the peritoneum. This cavity connected with a loop of the colon—at quite a distance from the artificial anus. His condition continued to improve upon free drainage of this cavity, but before we could do the necessary intestinal resection he too was transferred to a hospital farther south.

Some of the minor methods and appliances are quite different from those used in America, and appealed to me as being well thought out and worthy of wider use. Much skill was shown in the application of plaster casts for compound fractures that need daily dressings. Under anæsthesia, if necessary, the limb was put in the desired position and the cast was applied in two parts, one above and one below the wound. When about half on, previously prepared iron wire handles were embedded in the cast so that when covered with the plaster bandage they held the two parts of the cast firmly in one piece, at the same time being so bent that they were well away from the wound. They also formed most convenient handles for moving the injured limb. Just before the cast was dry it was coated with talcum powder, well rubbed in. This makes a smooth, almost glassy surface, which is readily washed. In addition the date of application is always written on the cast.

A very ingenious method of applying a cast for either simple or compound fracture of the humerus was noted. In a sitting posture, with or without anæsthesia, the patient has a bandage tied around the forearm close to the elbow, the forearm being at right angles to the arm. A similar bandage is applied at the shoulder. Assistants make sufficient traction on each bandage to overcome the shortening; then, with the bone fragments held in the proper position, the plaster is applied from the shoulder to the elbow, a window being left, or made afterward, if there is an open wound. When carefully applied and padded this holds the humerus in perfect position without a complicated weight and pulley apparatus. Traction must be maintained until the plaster has hardened, and it must be understood that the cast is long enough to include the elbow-joint and fit snugly against the shoulder. A case in point is as follows: A civilian, well along in the seventies, was run over by an automobile, suffering, besides other wounds, a compound fracture of the middle of the right humerus. Street dirt was thoroughly ground into the wound, which promptly became infected. Although his general condition was far from favorable (he was delirious and had considerable fever), a cast was applied in the manner mentioned, without anæsthesia. The reduction was well maintained, the infection cleared up under the use of Dakin solution and his convalescence was as smooth as could be desired. One obvious advantage of this apparatus is that the patient need not be confined to the bed, a great consideration in a case such as this.

The antiseptics used in dressing open wounds: For cleansing purposes, both in the wound and of the area surrounding, gasoline to which has been added just enough iodine to make it a bright pink is a most

satisfactory solution. It causes little or no pain, even in an open wound. Probably every antiseptic known to man has been employed to moisten the dressings used in packing wounds, and personally I am satisfied that carefully prepared Dakin solution is the most efficient. I might say that to get results comparable with those obtained at Dr. Carrel's hospital at Compiègne, the utmost care is needed, particularly in the microscopical examination of the wound secretions. This is a pretty difficult matter in a town such as Melun, where we had six hospitals and one overworked bacteriologist. If I remember rightly I was told at Dr. Carrel's hospital that nurses were easily trained for such work, but we did not have even graduate nurses, or, for that matter, a sufficient number of microscopes. Dakin solution is most excellent for wounds, even when not used by Carrel's method. Wet dressings are covered with oil silk. This, when properly applied, will keep dressings moist for many hours.

One more minor appliance is worthy of mention. It consists of a rope hanging from the ceiling above each cot and reaching to within eighteen inches of the patient's chest; it terminates in a wooden handle some four or five inches long. Unless a man is wounded in both arms, which is rare, he is able to raise and shift himself surprisingly well. As the orderlies have but little time for such minor attentions as arranging pillows or shifting patients to a more comfortable position, this simple appliance adds greatly to the comfort of the wounded.

As stated before, burns—that is, serious burns—are treated at special hospitals. I wanted to visit de Santfort's Hospital at Issy-les-Molineaux to see his work along this line, but I could not find the time. But I have talked to men who went there thoroughly skeptical and came away equally thoroughly convinced. They tell me the results from the use of his "Ambrine" are simply incredible, unless one sees them for himself. "Ambrine" is a secret combination of certain waxes with paraffin. It is applied hot to the whole burned surface. One of the most remarkable effects is that it stops pain at once. The dressings are changed daily and healing takes place rapidly, many times with little or no appreciable scar.

At one of the Russian hospitals in France a solution of soap is being used in the treatment of wounds with remarkably good results. This is another place I wanted to visit, but again I had to accept second-hand reports.

I visited both the London and the Paris Radium Institute, and was especially impressed with the work that the physicians of the latter—Dr. Degrais in particular—are doing on war wounds with radium. The most thoroughly satisfactory cases were those treated for vicious scars and the deformities caused by them. Some "before and after" pictures spoke eloquently for the aid that radium can give.

In closing, let me emphasize the smooth-running system that France has devised for her Medical Corps in caring for the wounded and sick of a tremendous army. Pitifully unprepared when the war broke out, she

has met the many difficult problems in a straightforward manner and now stands as an example of what a united country with a single purpose can accomplish. Winning this war has become the intimate personal business of every French citizen and that is the spirit that sees and gains only victory.

In entering upon this greatest of wars, I feel that we can learn much from our sister republic, and among the lessons that are not least important are those of the organization, equipment and smooth working of the Medical Corps.

THE X-RAY IN WAR SURGERY AND ITS RELATION TO THE REMOVAL OF FOREIGN BODIES

SPECIAL REFERENCE TO OPERATING WITH SYNCHRONOUS ASSISTANCE OF THE FLUOROSCOPE

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and

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assistant surgeon, reserve hospital no. 8, vienna, austria

For convenience sake we have divided the matter of this article into three divisions: I. Establishing the presence of a foreign body. II. Establishing its location. III. Removing the foreign body.

I. The present war has emphasized the great value of the fluoroscope as a diagnostic agent and its superiority in general over the plate method. With a little training, with a tube slightly harder than usually used for fluoroscopic purposes, and with a small diaphragm, minute metal splinters are seen in the extremities and pea-size fragments are seen in the abdomen and skull. Holzknecht of Vienna goes so far as to claim that barley-corn-size splinters in the cranium come within the practical limits of the fluoroscope. In our cases over 90 per cent. of lodged bullets were observed with the fluoroscope and less than 10 per cent. were discovered by means of plates or first observed when discharged with the secretions into the dressings.

Unless we use the fluorescent screen we are very likely to overlook bullets because large areas must be searched. Bullets are not always where one expects to find them. A bullet canal of one metre in length is not at all unusual, nor is it a rare occurrence to find a bullet lodged at some point of the body, to reach which, in a direct line from its entrance wound, it would have had to pierce several vital organs. For example, we had one case with an entrance wound just to the left of the sternum at the fifth interspace. The patient gave no sign nor symptom other than vague general pain in the left side in breathing and a rise in temperature which, however, soon abated after the bullet was removed from under the left scapula. In cases like this, bullets would frequently be overlooked if a plate or two were depended upon for diagnosis. The number of plates required to cover the areas where a bullet might be would not only occasion a great amount of needless labor, but also a large expense and a waste of time. Occasionally where a diagnosis must be made while a cast or splint is worn, a plate must be used.

It is well in taking photographs, as also in examining with the fluoroscope, to observe the part in more than one direction, because a small

projectile covered by a large heavy bone can very easily be overlooked. Luckily, however, any foreign body which is so small as to be overlooked by the fluoroscope will not often produce symptoms.

Due to the expensiveness of plates, most of the hospitals in Vienna have attempted to substitute paper, similar to that used in making copies, but stiffer. The technic is the same as with plates, except that a harder tube and a longer exposure are necessary and that a screen must always be used. The exposure is made with the emulsion side of the paper against the screen, sending the rays first through the paper. The

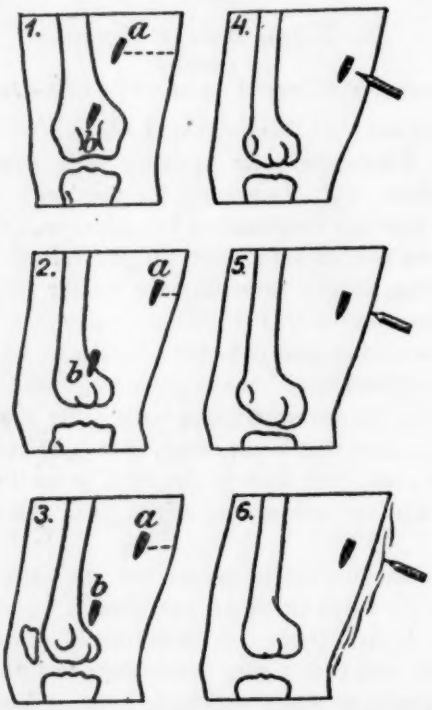

FIG. 1.—1 and 2, rotation until bullet *a* lies in the "shortest skin foreign-body line"; 3, rotation until *b* lies in longest bone foreign-body line; 4 and 5, marking site of bullet by sliding pencil about limb until whole pencil is outside of tissue shadow; 6, same on bandage. (Holzknecht: *Münch. med. Woch.*, 1914, No. 45.)

resulting pictures are good enough for finding coarse metal fragments. Paper negatives should not be used for detail work.

II. Much more difficult than the determination of the presence of the foreign body is to determine its position. Here again the fluoroscope is of inestimable value. A very simple method for making rough localizations, especially in the extremities, is simply to fluoroscope the part in as nearly as possible perpendicular directions, marking the projections of the foreign body on the skin with blue pencil. Another common method is to rotate the patient under the fluoroscope, keeping the distance from the bullet to the skin in mind, and ascertaining where this is the smallest. This distance is for all practical purposes the depth of the bullet. Then

with a skin pencil the site of the bullet is indicated by encircling the skin with the pencil held parallel to the screen. The pencil point marks the site of the bullet when the whole pencil is outside of the shadow of the soft parts (Fig. 1). This method can also be used to determine the distance of the bullet from the skeleton as well. Here the point where the bullet is farthest from the bone is chosen and marked as the near point. Skeleton localization is a good method, especially when the soft tissues are very swollen or œdematous or when the foreign body is lodged near the bone.

In all localization, either by fluoroscope or plate, a good axiom to keep in mind is that a foreign body lies outside of a hollow cavity or bone

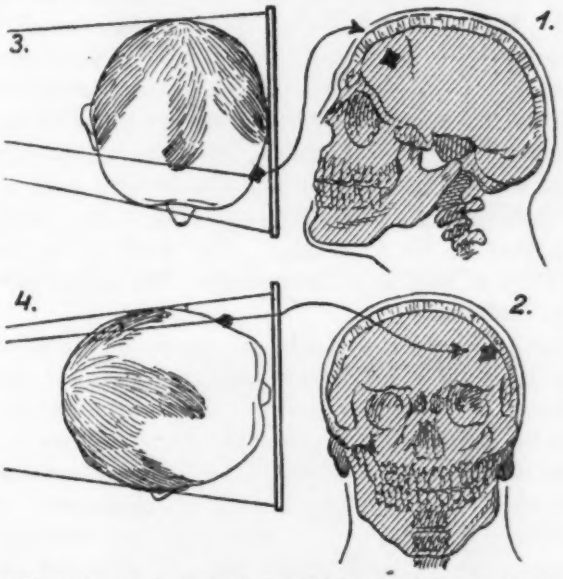

FIG. 2.—1 and 2, X-ray pictures of a foreign body which in spite of the two pictures seems to lie within the cranial cavity; 3 and 4, the foreign body is stuck to the skin with adhesive. Its projection inside of the skull is only apparent. (Holzknecht: *Münch. med. Woch.*, 1914, No. 45.)

when on the screen or plate at any one time it appears outside, but inside the cavity or bone only when at no time whatsoever during the rotation is it seen outside. Dr. Holzknecht, of Vienna, has especially emphasized this.

In his article in the *Münchener medizinische Wochenschrift* for 1914, No. 45, Holzknecht has ingeniously demonstrated the fallacy of the common way of taking pictures in two parallel directions and relying upon this to localize the bullet. He showed pictures of a bullet which apparently seemed to be deeply lodged in the brain, when in reality the bullet was held to the temple by means of adhesive strips (Fig. 2).

When the above described methods of localization have not sufficed we have made use of one of two other methods.

The first of these is that of Holzknecht, Sommer and Mayer, as de-

scribed in the *Münchener medizinische Wochenschrift,* 1916, No. 14, and is as follows:

With the diaphragm of the tube as small as possible the tube is set under the foreign body and its image noted on the fluorescent screen which is held above the patient, perpendicular to the X-ray, on a standard, and the site of bullet marked on the skin. The diaphragm is thrown as widely open as possible and the tube moved in one direction until the foreign body just disappears. Its projection is marked on the screen. The same step is repeated, moving the tube in the opposite direction, and again a mark is made on the screen. The distance between the two marks is read off on a scale and the result equals the distance (in centimetres) the projectile lies under the under surface of the screen, at point marked. The scale is easily constructed once for all, for any given table, tube or standard, by following the same procedure with a metal body at the end of a 10 cm. long rod which is attached with adhesive perpendicular to the under surface of the screen. The method is very satisfactory and gives for all practical purposes an exact figure, can be carried out on any X-ray machine and requires no special instruments. It is easily, quickly and cheaply accomplished. The other method we have used is that of Dr. Kautzky. The method requires a special apparatus, a plate as well as a fluoroscope. We prefer the more simple method of Dr. Holzknecht.

The method of localizing a bullet by means of the stereoscopic tube has been used by some with good results. We cannot quote from personal experience. To give an account of the innumerable localization devices would be a long and difficult task. Dr. Wachtel, of Wien, states that before the war there were already over one hundred different modifications. Since the war the number has greatly increased. All fail in one or more practical points. They are either too expensive or too clumsy, or too complicated or too inaccurate, etc. The object of localizing a bullet is not only for diagnostic purposes, but in the great majority of cases to assist the surgeon in its removal. All localization devices fail in this last-mentioned duty for one or all of several reasons. That this failure is a real one will be acknowledged by any surgeon who has attempted to remove even a small number of lodged bullets. Objects whose localization has been such that their removal ought apparently to be a simple matter have often required several hours of searching until found, or occasionally until given up in despair.

Fig. 3 shows a case where a competent surgeon searched forty-five minutes until the bullet was found, although, judging from the X-ray picture, it seemed a very simple matter. Again, large wounds must be made so that the tissues can be more readily investigated or the tissues themselves badly mauled before the elusive fragment is discovered. The reasons for this are evident. Every change in position of the patient changes the position of the bullet. A bullet lying 3 cm. below the skin

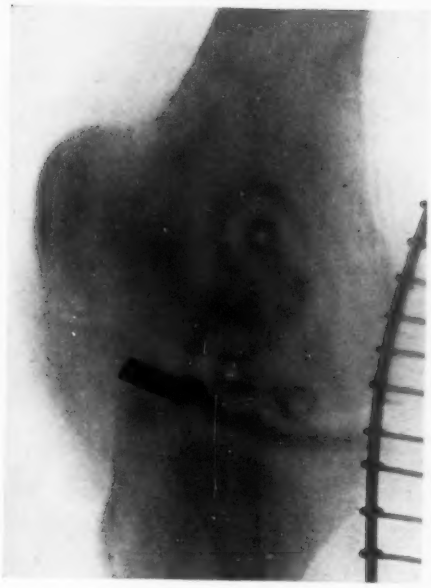

FIG. 3.—Bullet apparently easy of removal eluded search for an hour until found with cryptoscope.

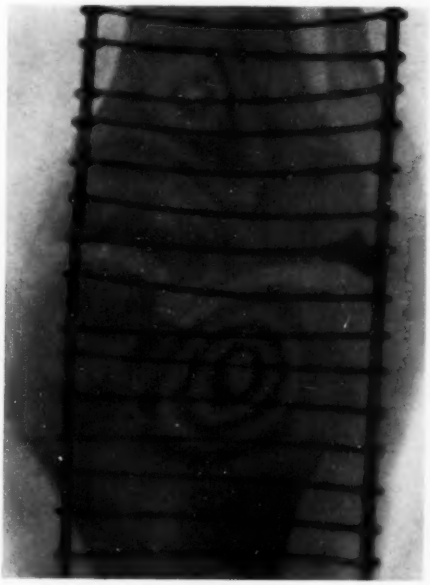

FIG. 4.—Bullet apparently behind femur. In reality anterior to femur.

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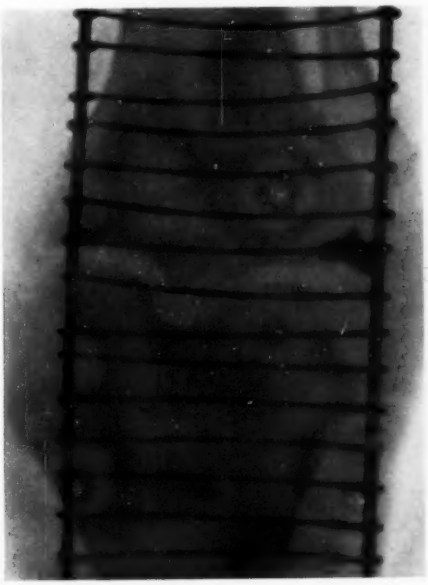

FIG. 4.—Bullet apparently behind femur. In reality anterior to femur.

FIG. 5.—Cryptoscope with screen closed.

FIG. 6.—Cryptoscope with fluorescent screen raised.

FIG. 7.—Bettman cryptoscope.

at the time of the localization may at operation be found twice as deep, because the position of the patient is only apparently the same as when the bullet was localized. A muscle relaxed during an anæsthesia will change the position of a lodged bullet many centimetres from the position which it held while the muscle was in good tone as is the case in contraction. A bullet may follow along the course of tissue planes or down a fistulous tract, moving several centimetres in a few days. Fig. 4 shows a picture of a bullet located posterior to the femur, but which, while operating under Röntgen guidance several days later, was discovered anterior to the femur. Furthermore, as soon as the record is made the locating point in the skin is disturbed, retraction further disturbs relations. It is a great temptation to follow natural lines of cleavage and when these lie in practically the same plane as the line of approach to the bullet, it is very difficult not to be misled. A fragment becomes quickly encapsulated with firm fibrous bands so that it resembles the rest of the scar, and also so that it evades the knife.

III. *The Actual Removal of Foreign Bodies.*—The difficulties just mentioned, which are associated with the removal of bullets, are so real and so often present that we have adopted the method of assisting ourselves during the operation by synchronous fluoroscopic orientation. The idea is not new but originated almost immediately after the introduction of the Röntgen apparatus. Grashey, in 1904, constructed a monocular fluoroscope and thus originated the method of daylight operation with fluoroscopic assistance. Much credit is due Holzknecht, who by means of his elaborate machine placed this method of operating on a firm practical basis, and who in conjunction with many of the prominent Vienna surgeons, notably von Eiselsberg, has had extremely gratifying results. We have constructed a very simple and cheap portable operating fluoroscope with which we can accomplish the same results. Our operating cryptoscope, as it has been termed here in Vienna, is simply a light wood or card-board box, or, to be more exact, a truncated pyramid, which is held over the surgeon's eyes by means of two head straps. The base of the pyramid, which is 18 cm. by 13 cm. in size, is composed of a fluorescent screen, is on a hinge and, when released from a catch by pressure on a button, flies open under the influence of a spring. A piece of lead glass is inserted into the box to act as a shield. When the base is pulled down (Fig. 6) into position the surgeon is looking into a light-tight box, or, if in line with the X-rays, upon a fluorescent screen.

Our method of procedure for removing lodged bullets is as follows: The presence of the bullet is determined, its approximate position has also been ascertained by one of the methods mentioned. The path of attack has been planned, the skin area prepared in the usual manner and the patient placed on the X-ray table as if on an operating table. A tube (we use the same tube which we use for fluoroscoping purposes) is in the under table stage. The field of operation is lighted by daylight or strong artificial light. After the surgeon and assistants are sterile, the

cryptoscope covered with a sterile cloth is placed over the eyes of one of the assistants. He closes the screen, or base of the apparatus, the X-ray machine is set in function and the assistant now localizes the bullet as he would with the aid of the usual fluorescent screen in a dark room, by means of a metal instrument. The surgeon makes a small incision, working down to the bullet, being guided by the assistant, who is watching the operation on the fluoroscope and who guides him verbally or by means of a pointer down to the bullet. It will often happen that after the incision has been made the assistant himself by blunt dissection with a clamp can separate the tissues and grasp the bullet. He sees the silhouetted clamp approach the metal shadow, he sees this shadow move with every little impulse of the clamp when he has reached it. As he opens the clamp slowly he can see the jaws stretch over the bullet, he can see that he has grasped the bullet. He then releases the screen and in full light very carefully, so as not to cause any injury to neighboring tissues, he withdraws the bullet. Great care must be taken in doing this. If the bullet does not come away easily it is much better to prepare down to it, loosen its adhesions and make sure that, although very carefully applied and under direct scrutiny of assistant by means of the fluoroscope, the clamp has not included besides the projectile some tissue structure. Often in simple cases the surgeon himself wears the cryptoscope, operating with the screen released and orientating himself from time to time by closing the same and looking at the bullet with the fluoroscope. Most tubes will not stand the strain of continuous use throughout the operation, our tubes among them. In this case we use the fluoroscope only at intervals to guide the surgeon back to the right path or to confirm his progress.

In order to shield ourselves from the injurious effects of the X-ray, a 1 mm. aluminum filter is placed over the diaphragm. Furthermore, the diaphragm is narrowed so that the whole shaft of light falls within the margins of the screen. We operate the diaphragm with our knees by means of stirrups fitted on the handles. Of course where good tubes are used and the means permit, the X-ray table can be placed in the operating room, and the current conducted by means of cables.

The results have been striking in many cases. Bullets for which a long search has been made, often repeated searches, have been quickly removed when the search was aided by the cryptoscope. Time and again the surgeon was unable to find the bullet until the röntgenologist pointed to its location directly in the walls of the wound, or under a retractor or a tissue sheath. The average time for a foreign body operation has been reduced fifty or seventy-five per cent. Tissues are not needlessly traumatized nor are large wounds made where small ones suffice. We have also used this method with similar success in a few cases of needles in the hands of some of our hospital servants and warmly recommend its use for such cases.

A METHOD OF PRECISION FOR THE REMOVAL OF NEEDLES IN THE HAND: THE USE OF THE MICROPHONE*

By Kenneth Bulkley, M.D.

of New York

Associate Visiting Surgeon, Bellevue Hospital

(From the Cornell Surgical Division, Bellevue Hospital)

Through the kindness of the Directors of the four Surgical Services of Bellevue Hospital, I have been able to collect from the Hospital records 72 cases of needles in the hand or foot. It is the experience gained from a study of these and my own cases which I wish to report at this time.

In 54 (or 75 per cent.) of the cases the needle was in the hand, and in 18 (or 25 per cent.) it was in the foot.

Needles in the feet most commonly gain access to the sole while the individual is walking barefoot. In this series they have been encountered with equal frequency in children and adults. I was previously under the impression that they occurred mainly in children. In the hand there are three main ways in which the accident occurs. The most common is in washing clothes, 53 per cent. of the hand cases occurring in this way. Next in frequency is in scrubbing a floor or in some similar motion in which the hand is usually pierced by the eye end of the needle. The third is by machine needles, in which the machine is started while the operator's hand is still within the range of motion of the needle.

Curiously enough, it is rather unusual for an infection of any severity to develop following the implantation of a needle. Relatively few abscesses develop and the superficial cellulitis, if it occurs, is usually not severe and is self limited.

In a finger or thumb pulp, either a central fragment of a machine needle or a pointed end of a hand sewing needle is usually found. It is uncommon to find a needle anywhere in the finger except in the pulp. The majority of needles enter the hand on the palmar aspect within an inch of the os magnum, and assume their final position almost immediately, this position being determined largely by the direction of motion of the hand at the time of impact and the immediate subsequent attempt, usually made by the patient but only too often by the physician, at removal. Thus they may be found in the thenar or hypothenar eminence, in the midpalm, in the tissues in front of the wrist, or in the musculotendinous mass just above the wrist.

* Read before the Surgical Section of the New York Academy of Medicine, February 2, 1917.

The distribution in the hand cases in this series was approximately as follows:

Thumb or finger	20 per cent.
Thenar eminence	44 per cent.
Hypothenar eminence	10 per cent.
Front of wrist	10 per cent.
Remainder of palm	10 per cent.
Dorsum of hand	4 per cent.

Not all embedded hand or foot needles give rise to symptoms. We have seen cases which did not know of the presence of a foreign body until an X-ray picture for some other condition was taken. A letter was recently received from a patient who has carried a long needle fragment high in the arch of the foot for five years without symptoms. And not long ago I removed the eye end of a needle which had lain along the flexor surface of the index metacarpal for nearly nine years, only shortly before operation giving rise to symptoms.

But sooner or later a majority of these patients do have discomfort due to the presence of the foreign body. The symptoms are often slight but very definite and persistent, and frequently do not make their appearance until some time has elapsed since the injury. Pain on pressure, so that the firm grasping of an object in the palm is uncomfortable or impossible, is the symptom most commonly encountered. Limitation of flexion or extension of a finger is at times seen, and almost invariably means a palmar needle piercing at some point a tendon or its sheath. Needles in the thenar eminence seldom give rise to this symptom.

Patients apply for the removal of these needles in two groups. The first group includes those who largely from fear of immediate or remote trouble apply for removal at the earliest possible moment after injury. In the second group I place those patients who, because of the development of symptoms at a later date, apply for the removal of the needle. I believe that the majority of patients in the first group, if the needle is not removed, eventually become members of the second group.

Numerous devices have been suggested for the localization and removal of these needles. For accurate localization, the triangulation X-ray photographs and the stereoscopic radiograph are of the greatest assistance. The ordinary method of surface marking has been greatly improved by the checker-board marking described in 1913 by Dr. Brown.

But the greatest difficulty has always seemed to me to be not so much in the localization of the needle *before* incision, as in its recognition at time of operation. If, on incision, the needle comes at once into view, the problem is solved. But embedded needles are frequently buried in the muscular thenar eminence. lie longitudinally in a lumbrical muscle or flexor tendon, or hide in the most adept manner in one of the interossei. To *see* a needle so hidden means a large incision, wide

retraction, and often considerable injury to muscle or tendon, all these factors tending to lengthen the time of operation and to enhance the possibility of infection. To be always able to *feel* a needle with the examining finger partakes of the supernatural. I question either the memory or the experience of the man who states that he has never failed to find a needle by the ordinary dissection method. Of course, one may, if fortunate, have the opportunity to work under the guidance of the fluoroscope. but this is not always available.

To show that the difficulty of finding these needles is not exaggerated, I have analyzed the records of 72 hospital cases. In 8 cases, for one reason or another, no attempt was made to find the needle. In the remaining cases operated on by the ordinary dissection method, the results are instructive. These are not dispensary patients, but patients admitted to the wards of the hospital. The results are as follows: The needle was found on the first attempt in only 47 per cent. of the cases, 17 per cent. with local and 30 per cent. with general anæsthesia. The remaining 53 per cent., in which more than one exploration was done, divide themselves as follows: In 13 per cent. (9 per cent. with local and 4 per cent. with general anæsthesia), one attempt only was made and the needle not found. In 24 per cent. the needle was found on the second attempt, all under general anæsthesia; of these 16 per cent. had been searched for previously under local and 8 per cent. under general anæsthesia. In 10 per cent. the needle was searched for twice and not found, all of this group having the benefit of general anæsthesia at least once. In 5 per cent. the needle was found only on the third attempt. And one patient was sufficiently docile to permit of five attempts at removal, two under local and three under general anæsthesia, before the needle was found.

These figures are rather disconcerting but nevertheless correct, as far as can be determined, for this series of cases. And they do not sustain the argument that to find and remove a needle is easy. I have seen no figures from other clinics and consequently cannot judge whether this figure is above or below the general average. But 53 per cent. of primary failures probably represents the general experience.

In looking about for some way of improving these figures, my attention was attracted to the microphone. This was first suggested in 1883 by Alexander Graham Bell and has since been used with varying success by a number of workers. It is really very simple, but like all things electrical requires some care and attention and also some electrical judgment.

As the theory of the apparatus has been described by the writer in a previous paper,[1] it need not be entered into here.

Fig. 1 illustrates the component parts of the instrument. The microphone now used has a combined resistance of 3000 ohms, thus being far more sensitive

than the commercial telephone receiver which has a resistance of 75 ohms. The wound electrode wire is insulated with rubber of sufficient purity to withstand sterilization. The rectal or mouth electrode is made of hard carbon and is moistened with water before insertion.

Fig. 2 illustrates the instruments commonly used. For removal of embedded needles an ear knife, a fine mosquito forceps, and an insulated needle, about size No. 5, only are necessary. The other instruments shown have proved useful for embedded metallic fragments other than needles. It will be noted that all instruments are provided with suitable attachment for electrical connection. I am at present using a needle insulated, except at its extreme tip, by Japanning.

Fig. 3 represents the instrument in use. No current of any sort is used other than that developed between the carbon electrode and the embedded metallic foreign body. As contact is better in a dry than in a bloody field, I have been in the habit of using a tourniquet. Local or general anæsthesia may be used, preferably the latter. The arrangement of wires is especially to be noted. Leading from the head piece is seen a single wire extending down the operator's back. At the right hip this divides into two, each provided with a connector, and these are separately pinned so that no contact between them is possible. This part of the apparatus is adjusted before the hands are sterilized. To one of these connectors is attached the wire leading to the carbon electrode—in Fig. 3 shown in the patient's mouth. To the other is attached an insulated wire which has been sterilized with the instruments. It is my custom, after careful localization with the X-ray, to make a half-inch incision and with a sharp insulated needle in circuit puncture the tissues at the desired point until electric contact with the embedded metallic foreign body is obtained. This is indicated by an unpleasant clicking sound heard in the microphone. There is a click on the make, another on the break of the current, and an irregular grating sound if the exploring instrument be rubbed along the foreign body. The exploring needle is then replaced by a small ear knife, the tract to the object sought enlarged, and contact again obtained. The knife is then replaced by fine mosquito forceps, contact again obtained, the needle grasped, and then removed either through the original incision or through a puncture point elsewhere. With this technic it is unusual to feel either with a finger or the examining instrument or to see a needle until it has been removed. The sense of hearing is alone employed. Contact has been obtained many times in less than ten seconds.

I have had the opportunity of using the microphone on 33 cases of embedded metallic foreign bodies, 25 of which have been needles. Of these 20 were in the hand. 1 in the foot, 2 in the capsule of the knee-joint, and 2 in the back. In over a third of these cases one or more previous attempts at removal by the ordinary dissection method had been made. The results are interesting and to me have been instructive, as I feel that I have learned from my errors. In 2 cases I have had difficulty. Fig. 4 shows a small needle fragment over the head of the middle metacarpal in the first of these two cases. The picture was taken two days before my attempt at removal. At operation I could obtain no contact and gave up the attempt. Fig. 5 shows why no contact

[1] Bulkley: The Telephone as used for the Localization and Removal of Metallic Foreign Bodies in the Tissues. Surgery, Gynecology and Obstetrics, 1917, xxiv, 366.

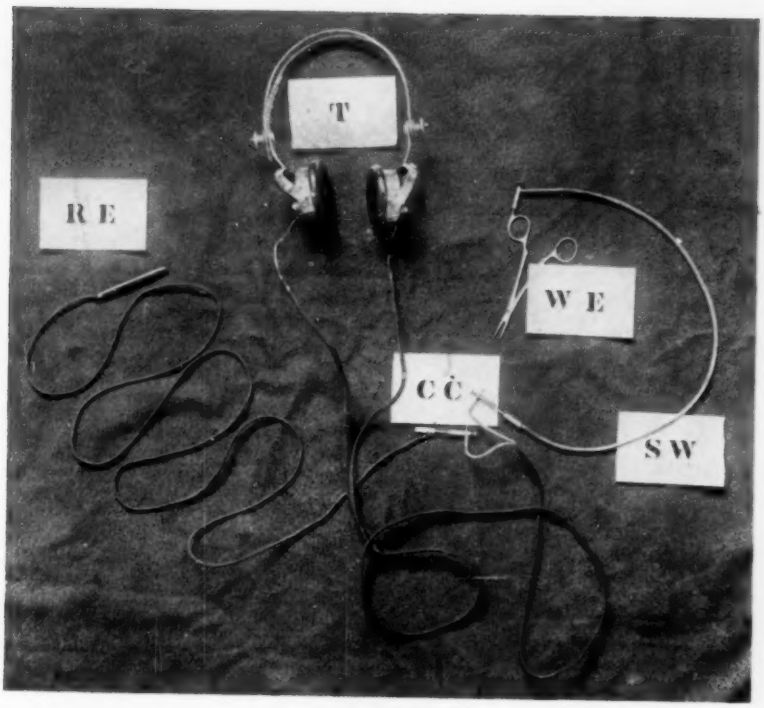

Fig. 1.

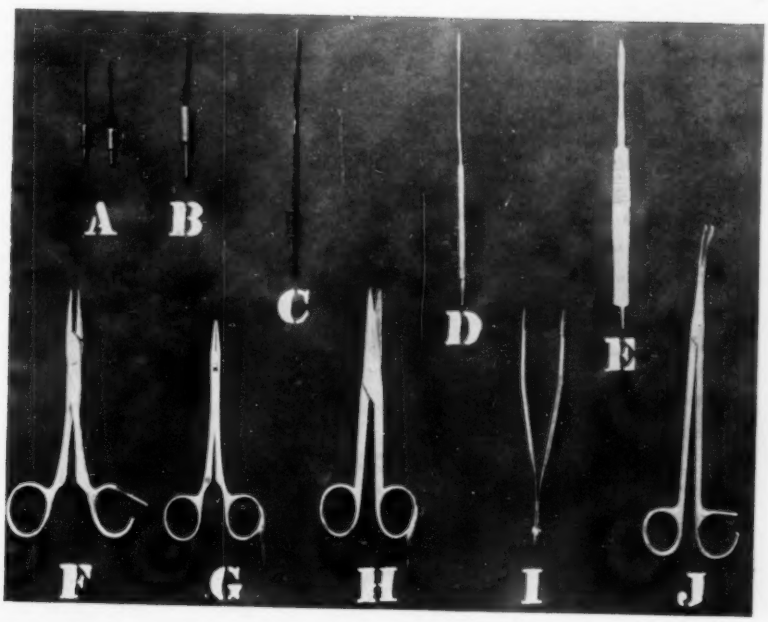

Fig. 2.

was obtained. The fragment lay 2 inches distal to its previous position, now being over the head of the proximal phalanx. On confirming this position with the fluoroscope, the fragment was readily located with the microphone and removed, and was found lying entirely free in the tendon-sheath with a range of motion of over four inches. The second case was that of a palmar needle close to the base of the ring metacarpal. The microphone was rendered useless in this case by the close proximity (in the next room) of a powerful dynamo, and I was unable to find the needle by the ordinary dissection method. I consider neither of these failures chargeable to the microphone. In the first case it was an error on my part not to obtain more careful X-ray localization, and the error in the second case was due to lack of electrical experience.

In none of the remaining 23 cases have I had much difficulty in localizing the needle. The usual operating time is about ten minutes, and until very recently I had never taken more than 20 minutes to obtain contact. In one case I was able to remove a lumbar puncture needle broken within the vertebral arch without resorting to a laminectomy; and in another case to find in granulation tissue without anæsthesia a needle which had been already searched for for four hours without success. I feel very strongly that a method capable of reducing primary operative failure in the removal of needles from 53 per cent. to 3 per cent. is worthy of more extended trial.

DEEP PALMAR HAND INFECTIONS

AN EXPERIMENTAL AND CLINICAL STUDY OF THE SURGICAL ANATOMY OF THESE CONDITIONS

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I. INTRODUCTION

Acknowledgment is due Dr. Henry J. Prentiss, Head of the Department of Anatomy in the State University of Iowa, for the generous use of material and facilities for the experimental part of this work, and especially to Dr. Dean Osborn, formerly assistant professor in this department, for the many valuable suggestions he offered in the study of the cross-sections and the preparation of the drawings. This experimental work was based upon that of Kanavel and the methods used were similar. The results substantiate those of Kanavel in most of the important details.

Methods of Study.—The hands used in this work were from cadavers which had been prepared for the dissecting room. The spaces to be studied were injected with a suspension of starch in water of the consistency of thin pea soup to which was added enough red lead to thoroughly color the mixture, and a few cubic centimetres of formalin to aid in the hardening of the mass after injection.

After injecting the spaces the hands were allowed to remain for twenty-four hours so that the mass would be completely solidified, and were then dissected and studied.

Three series of serial sections of hands which had been injected were made, two of which are shown in part in the accompanying drawings. These sections were made by injecting the desired spaces according to the technic described above, and then the hands were frozen solid in a block of ice in the artificial ice plant of the University Hospital for twenty-four to forty-eight hours. Then they were removed from the ice and the frozen hands cut into transverse sections by a band saw in the university shops.

II. ULNAR BURSA

The relationship between the ulnar and radial bursæ is a very close one. Dr. H. J. Prentiss states that in the dissecting rooms where the thecæ are demonstrated by the students by distending them with compressed air, communication between the two bursæ is apparently present in about one-third of all the bodies. In the injection experiments which formed the basis for this study, the injection mass filled both bursæ when injected into either one, in every instance except one. These observations are not conclusive, of course, because the

force used in the distention of the thecæ with air or fluid mass may have ruptured the thin bursal walls and formed an artificial communication. On the other hand, the cases observed in the clinic of the University Hospital during the past two years and in the course of an interneship at the Cook County Hospital in Chicago, probably ten in number, all showed infection involving both bursæ where one, from the history, had been primarily involved. It may be, however, that the accumulation of cloudy fluid present in one of the bursæ when the infection indubitably was primary in the opposite represents not an extension of the infection to that bursa, but rather the exudate which is characteristically poured out from a serous surface incident

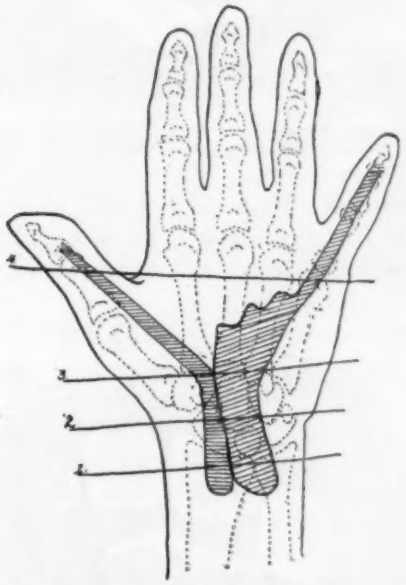

FIG. 1.—Radial and ulnar bursæ. Showing levels at which cross-sections were made. Injection was made into the ulnar bursa and the mass also passed into the radial.

to any infection of the tissues in its immediate neighborhood. Practically, it would be very difficult to differentiate between such an exudate and a frankly infected exudate without opening the bursa.

Relations of Bursa to Flexor Tendons (Figs. 1–5).—In this case the injection was made into the theca of the little finger, and the mass filled not only the ulnar bursa but also the radial.

The ulnar bursa is a serous-lined sac which extends from a point one and one-half to two fingers' breadth above the wrist-joint (proximal wrist crease) to about the middle of the palm and continues along the flexor tendons of the little finger as their common theca. At the origins of the lumbrical muscles from the flexor tendons of the second, third and fourth digits, the bursa loses its relationship to these tendons in the normal condition. Rarely, however, there will be direct com-

munication between the theca of one of these digits and the ulnar bursa. More commonly than this there will be a break in the continuity of this bursa in its extension along the tendons of the little finger.

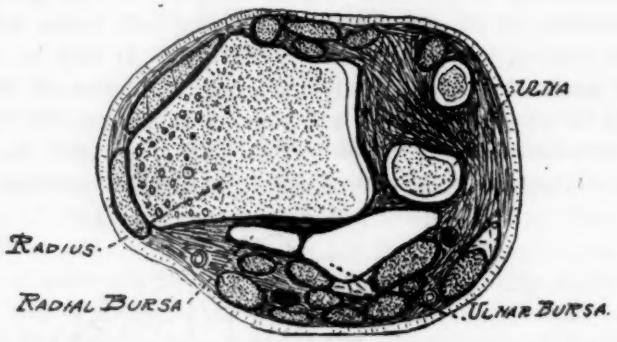

FIG. 2.—Radial and ulnar bursæ. Section No. 1. Note that the bursæ are entirely behind the group of tendons at this level, and are in intimate relation to the ulna and radius and the wrist-joint.

From the standpoint of infection of this bursa, one of the most important points to be brought out is its deep location throughout in relation to the tendons. In its proximal portion, it lies distinctly

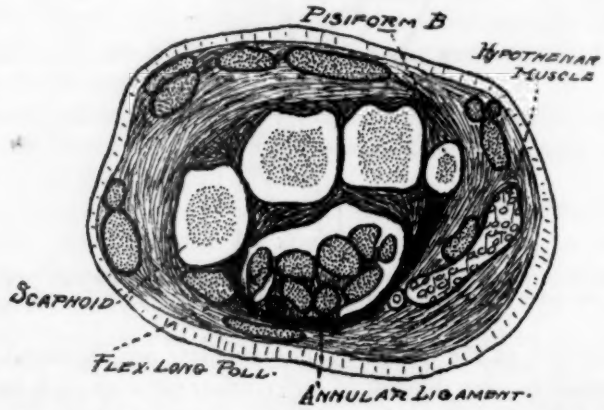

FIG. 3.—Radial and ulnar bursæ. Section No. 2. The bursæ at the level of the carpal joint extend somewhat anteriorly to lie under the annular ligament. Mostly, however, they are behind the tendons and are closely related to the carpal bones and the carpal joints.

behind the entire group of tendons and their muscle bellies (see Fig. 2), so that by careful dissection these tendons may be lifted completely away from the bursa, leaving it *in situ*. The relationship becomes more intimate as the tendons approach the hand, although at the level of the wrist-joint the bursa still lies entirely posteriorly. Between the wrist-joint and the distal level of the annular ligament, the tendons begin to be enveloped by the bursa, especially on the ulnar side, and the individual tendons of the profundus group project to a greater

extent into the bursa, but are not completely invested by it. That the investment is not complete is due to the fact that the individual tendons are still connected by a definite fibrous tissue pedicle, the mesotendon, to the remaining tendons of the group, and the synovial lining of the bursa is reflected back along this pedicle to the neighboring tendon and its pedicle (see Fig. 3). Below the annular ligament the tendons of the little fingers become more and more completely invested (Fig. 4) until at the level at which the bursa continues along these tendons as their theca (Fig. 5) the investment is complete, and the tendons lie free as in a sac.

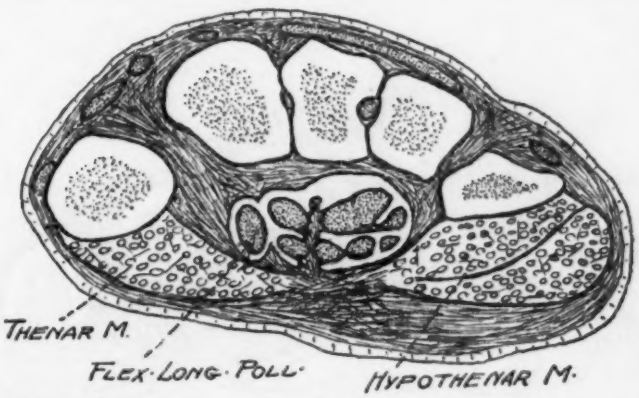

FIG. 4.—Radial and ulnar bursæ. Section No. 3. The radial bursa is seen separating from the ulnar and completely surrounds the tendon of the M. flexor pollicis longus. Note the intricate arrangement of the ulnar bursa in relation to the various tendons.

The complexity of the bursa is shown especially in Fig. 4, and illustrates how infection of this bursa cannot be taken care of by superficial inadequate drainage. There are many minor variations in the relations of the bursa to the tendon—so that no two dissections studied are entirely alike.[1] The specimen which is represented in cross-section approximates the usual condition.

Relations of the Bursa to the Forearm and Wrist-joint.—Above the level of the wrist-joint the ulnar bursa lies deeply under the tendons and directly upon the pronator quadratus muscle. At a higher level than the bursa the tendons and their muscles are separated from the radius and ulna and the pronator quadratus by a loose areolar connective tissue which presents but a poor barrier to the extension of pus when the infection has extended beyond the confines of the bursal sac. Toward the wrist the bursa lies directly upon the radius and

[1] Dr. H. J. Prentiss observed a case in the dissecting room in which the ulnar side was in relation only to the tendons of the fourth and fifth fingers and continued along those of the fifth as in the normal condition. That portion lying on the radial side communicated with the radial bursa by a small foramen. There was no communication whatever between the two portions of the ulnar bursa.

ulna, and at the level of the wrist-joint is separated from the latter only by the ligaments of the joint (Fig. 2), while above lie the flexor tendons covered by the tough vaginal fascia which envelops the forearm, and acts as a barrier to the extension of pus laterally.

Relations to Carpus and Annular Ligament.—At the level of the proximal pillars of the carpal arch the bursa is seen to lie in a space which is uncompromising in its rigidity. Laterally and posteriorly the confines of this space are the carpal bones and their ligaments, while anteriorly the roof of the space is formed by the tough resistant annular ligament. The relationship to these structures is so close that it is difficult to dissect the bursa free from them without destroying its integrity. Furthermore, it should be remembered that the bursa

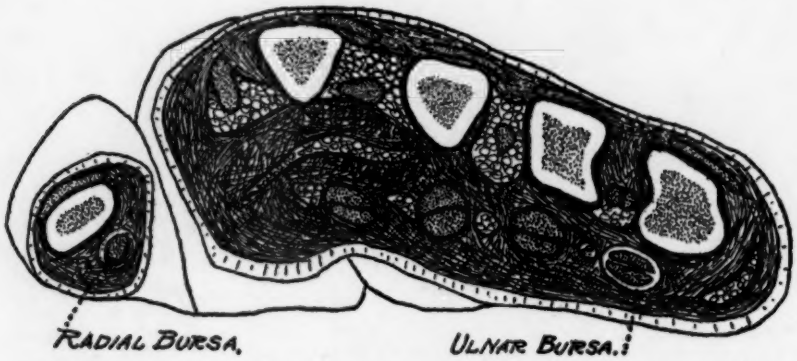

FIG. 5.—Radial and ulnar bursæ. Section No. 4. Note the extension of the bursæ along the tendons of the thumb and the little finger. All relations between the bursæ and the tendons of the second, third and fourth fingers are lost at this level.

still lies in much its greatest extent behind the tendons. At the level of the distal row of carpal bones the space becomes decidedly narrower and the bursa even when distended by injection mass or by pus is very much smaller in cross-section than either above or below this level. Furthermore, the bursa assumes a still more intimate relationship with the bones of this distal pillar and the joints between them. On the other hand, the bursa has begun to extend anterior to the whole group of tendons and a small portion of it lies directly under the tough annular ligament on the ulnar side.

Relation to Metacarpal Bones.—Just distal to the level of the annular ligament, the bursa lies directly upon the three medial metacarpal bones and to a small extent over the second metacarpal. At levels below this, however, intervening between the bursa and these bones are, first, the mid-palmar space, and second, the interossei muscles, and, to a certain extent, the palmar thenar space, where it lies upon the M. adductor pollicis. The importance of these relations is that infection extending dorsalward from the ulnar bursa in the palm of the hand would involve first the mid-palmar space or, on the radial

side, the palmar thenar space. Beyond this there would be quite a barrier to further spread dorsally by the metacarpal bones with their interosssei muscles and their fascial coverings.

Relations to Palmar Fascia and Skin.—As has been shown the bursa is covered in the forearm and wrist by either the flexor tendons, the annular ligament, or both. Distal to the annular ligament the bursa lies in part—although still a lesser part—distinctly anterior to the general body of tendons, although some of the sublimis group still lie above the bursa. It is covered, however, by a very tough, thick, resistant fibrous tissue, the palmar fascia, and an equally tough layer of skin which affords a definite barrier to the extension of pus in this direction.

Relation to the Mid-palmar Space.—The ulnar bursa in its location in the hand lies directly upon the mid-palmar space and the relationship between the two is very intimate. The latter, however, besides being more deeply situated, extends distally to a lower level than does the ulnar bursa in the palm (see Fig. 15).

Relation to the Palmar Thenar Space.—The ulnar bursa lies for the most part on the ulnar side of the palmar thenar space and to a small extent over it, and the relationship is a close one, so that the extension of pus from the latter to the former would be readily possible.

It should also be noted that the palmar thenar extends to a lower level in the palm than does the ulnar bursa. There is no direct relationship between the ulnar bursa and the dorsal thenar space as the M. adductor pollicis lies between them.

Extension of Infection Beyond the Ulnar Bursa.—Because of the relationships which exist between the ulnar bursa and the structures contiguous to it, extension of infection or rupture of pus beyond the confines of the bursa occurs in certain definite and understandable locations.

Foremost amongst these is into the radial bursa. The specimen from which the serial sections were made illustrates this point. As has been stated, in a fairly large percentage of cases a normal communication exists between the two bursæ, and infection of one means of course infection of the other. Aside from these, however, the infection from the ulnar bursa extends into the radial in the majority of cases in which the ulnar is primarily involved. Whether this extension is through the unbroken synovial sac, or whether the synovial wall is ruptured, is impossible to state and is really immaterial from a clinical standpoint. The important consideration is that the infection may extend rapidly throughout the entire length of the radial bursa and increases the complexity of the condition as regards treatment, complications and ultimate deformity.

The mid-palmar space is not infrequently involved in neglected cases of ulnar bursa infection (Fig. 15). It alone may be involved or the pus may also have invaded the palmar thenar space causing an extensive abscess lying deep in the palm. The rupture from the bursa into the space usually takes place on the posterior surface of the former at the point where the bursa is interrupted along the tendons to the third and fourth fingers by the origins of the lumbrical muscles. If the rupture occurs from the bursal projection along the tendon to the index finger, and this is much less frequent, the pus will then invade the palmar thenar space rather than the mid-palmar, and the latter may or may not become later involved.

Extension of the infection in the ulnar bursa beyond its proximal confines is common (Fig. 15), and in this case there may be produced a rapidly extending cellulitis with the formation of pus which dissects the flexor muscles away from the radius and ulna and interosseous ligament—as high as the elbow. This pus tends to remain deep—for above it lie the muscles and tendons, and laterally and medially, as has been indicated, the tough vaginal fascia of the forearm tends to prevent it from pointing in these directions. In some cases in which the infection is of low-grade virulence the collection of pus breaking through the bursa does not spread rapidly and remains as an abscess in the lower part of the forearm with the tendons and the muscles floating upon it. In other cases the pus dissects its way between the bellies of the muscles and points at one or several places on the anterior or lateral surface of the forearm.

Not infrequently pus will point just proximal to the annular ligament on the anterior surface of the wrist, due to the fact that under this ligament the bursa lies partly anterior to the tendon group especially on the ulnar side, and the pus, being unable to penetrate the tough resistant ligament, works its way proximally and appears under the skin of the wrist. And occasionally, in neglected cases, the infection will point under the skin in the palm by burrowing through the dense palmar fascia.

Involvement of the carpal joints and bones, one of the very serious and frequent complications, is readily explained by the intimacy of the relationship between these structures and the ulnar bursa. The pus collecting in the bursa in the wrist is deeply placed, and firmly held by the unyielding structures surrounding it, so that extension to the carpus is inevitable in neglected cases. The same holds true regarding the wrist joint but not so strongly, for at this level the pus tends to work proximally, and breaking through the bursal confines, relieves the tension by extension up the forearm. Infection extending to one of the interphalangeal joints or the distal phalanx of the fifth finger should also be mentioned. This is not common.

III. RADIAL BURSA

This bursa is the theca of the flexor pollicis longus tendon and extends from a point about one and one-half to two fingers' breadth above the level of the wrist-joint, to the insertion of the tendon in the last phalanx of the thumb. Its relations to its tendon are about those which exist between the ulnar bursa and the tendons with which it is related. In the forearm it is deeply situated and lies behind the tendon.

In the wrist the bursa begins to partially envelop the tendon, and at the point where the tendon hooks around the trapezium to pass toward the thumb, the envelopment is complete.

Relation to Ulnar Bursa.—This has already been discussed. It may be noted that when a communication between the two bursæ is found, it is usually under the annular ligament or in the region of the wrist-joint, and varies in size from a very small foramen to almost complete absence of dividing wall.

Relation to Mid-palmar Space.—The radial bursa is not intimately related to this space.

Relation to Palmar Thenar Space.—This space, the boundaries of which will be detailed later, lies close to the radial bursa, especially at the level where the flexor longus pollicis diverges from the flexor tendons of the four fingers in the palm. The palmar thenar space and the radial bursa lie approximately in the same plane, but in some cases the latter has been found to partially overlie the former.

Relations to Carpal and Wrist-Joints and Annular Ligament.—The relations of the radial bursa to the carpal and wrist-joints are similar to those of the ulnar bursa. Where the tendon of the flexor pollicis longus lies under the annular ligament, it is nearly completely invested by its bursa. Consequently pus collecting in the bursa is present above as well as behind the tendon, and that lying above sometimes spreads toward the forearm to point in the wrist just proximal to the edge of the annular ligament.

Relations to Thenar Muscles and their Nerve Supply.—After passing around the trapezium, the flexor pollicis longus tendon now completely invested by the radial bursa lies to a certain extent under the thenar group of muscles. And in this connection it should be emphasized that the branch from the median nerve which supplies two and one-half of these muscles passes across the bursa to reach them, at a point between the annular ligament and a finger's breadth distal to it. This is of particular importance in relation to incisions made to drain this bursa, and has been brought out by Kanavel and later by P. Lecene.[2]

[2] Remarques sur le traitement des Phlegmons graves des gaines synoviales de la Main. Journal de Chirurgie, vol. vi, 1911.

Extension of Infection Beyond the Bursa.—Involvement of the ulnar bursa from an infection primary in the radial, has already been considered. Also infection may involve the wrist and carpal joints and extend up into the forearm, just as from ulnar bursa infection.

Extension to the palmar thenar space may occur, but clinically this takes place only after infection in the radial bursa has first extended to the ulnar. In this case the involvement of the palmar thenar space is probably by way of the ulnar bursa rather than the radial. Furthermore when the infection extends from the bursæ to involve the deeper spaces, it is much more common to have the mid-palmar space involved than the palmar thenar, and the infection may or may not then involve the latter.

Infection of the interphalangeal joint of the thumb sometimes occurs and occasionally osteomyelitis of the distal phalanx.

IV. MID-PALMAR SPACE [3]

The relations of this space are shown in Figs. 6-10.

It is shield-like in shape (Figs. 6, 9 and 10) and lies deeply in the ulnar half of the palm, *behind the flexor tendons* and the *ulnar bursa,* the latter overlying the mid-palmar space in its proximal portion. Distal to the ulnar bursa, the tendons of the third and fourth digits and their lumbrical muscles, as well as the lumbrical muscle of the fifth finger, overlie the space. Behind the space lie the third and fourth metacarpal bones and their interossei muscles and on the radial side the palmar thenar space which lies upon the M. adductor pollicis.

Proximally the space extends to about the level of the annular liga-

[3] In many of the hands which have been studied in the dissecting room, the middle palmar space and the palmar thenar space were lined by a definite, circumscribed glistening thin membrane in every way resembling that lining the ulnar and radial bursæ. In one of these cases histological sections of this tissue taken from the mid-palmar space showed the characteristic picture of synovium. In other specimens, tissue suggesting synovium was obtained, but it was not so definite, while in others the tissue was only compact connective tissue without the structure of synovium. These sections were all made from tissue taken from cadavers which had been preserved for a long time and the hands had become quite dried, so that clean-cut histological preparation was not possible, nevertheless we have been able to show conclusively that in one case at least, we had to do with definite bursæ rather than connective-tissue spaces.

It is readily conceivable why bursæ might be present in these positions in the hand. The ulnar bursa is interrupted in the palm in its relations to the tendons of the middle and ring fingers, by the origins of the lumbrical muscles from these tendons. The mid-palmar space takes the place of the ulnar bursa in this location. Similarly, the ulnar bursa loses its relation to the tendons of the index finger in the palm, and the palmar thenar space or bursa allows free play of these tendons upon the adductor pollicis muscle beneath it.

The dorsal thenar space is a connective-tissue space and there is no anatomical reason why it should be a bursa.

ment in the palm. Rarely it may extend even higher than this, but never into the wrist, because of the intimate relationship of the ulnar bursa to the carpus. Fig. 6 represents the highest extent of this space that has been observed in this work. Medially the space extends to

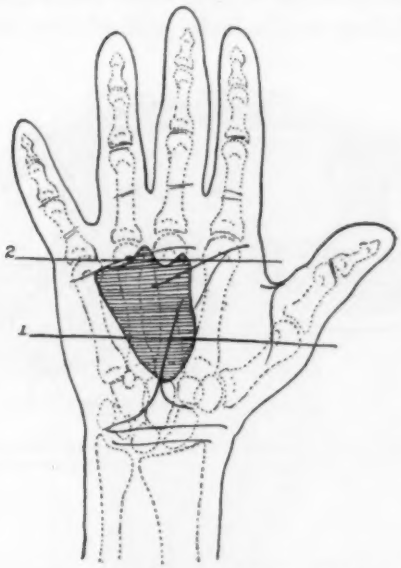

FIG. 6.—Middle palmar space. Injection was made directly into the space, and represents the usual shape and location. Note the projections along the lumbrical muscles of the ulnar three fingers. The levels of the cross-sections are indicated.

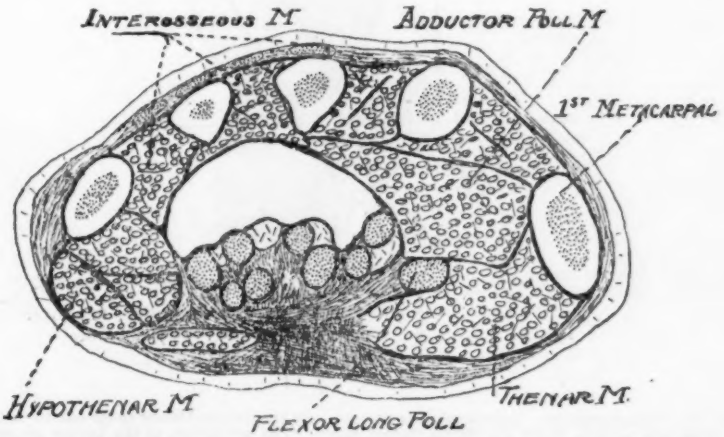

FIG. 7.—Middle palmar space. Section No. 1. Note the size of the space at this level. It does not extend radialward to the flexor of the index finger. It lies behind the tendons on the interossei muscles.

the tendons of the fifth finger with their bursal investment. On the radial side the space is limited by thin connective barrier which passes from the flexor profundus tendon of the index finger to the line of origin of the m. adductor pollicis from the middle metacarpal bone—

this connective-tissue wall separating the mid-palmar space from the palmar thenar space.

There is close relationship between the mid-palmar space and the lumbrical muscles of the third, fourth and fifth fingers. At the point where these muscles leave the tendons from which they take origin, the space is continued along on the under side of these muscles as definite

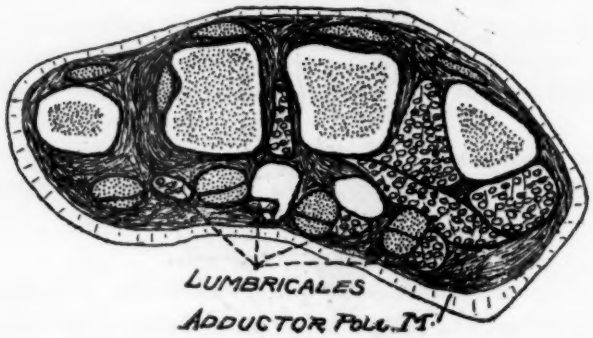

FIG. 8.—Middle palmar space. Section No. 2. At this level the characteristic prolongation along the lumbricales is shown. In this case it has not extended along that of the little finger to this level.

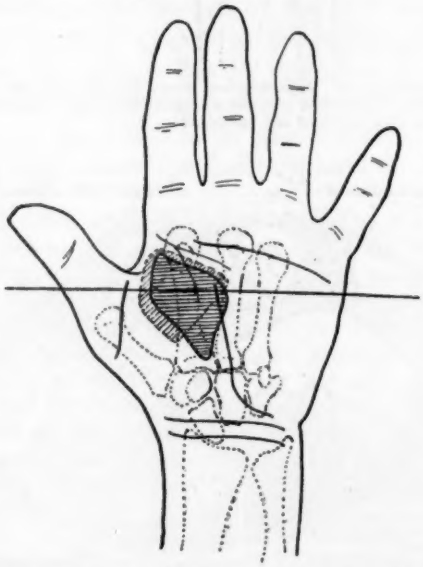

FIG. 11.—Thenar spaces. Injection made directly into the palmar thenar space passed through the M. adductor pollicis to fill the dorsal thenar space. The projection of the former along the umbrical muscle of the index finger is shown. Level at which a cross-section is shown as indicated.

prolongations. (Figs. 8 and 17). These are variable in extent, however, and may be lacking especially along the lumbrical to the fifth finger. This relationship does not exist between this space and the lumbrical muscle of the index finger. Toward the distal portion of the space at a level below the ulnar bursa, the space is more super-

FIG. 9.—Middle palmar space. Dissection showing the flexor tendons of the third, fourth and fifth fingers exposed. The annular ligament has been cut and reflected. The tendons to the index finger and thumb are shown drawn to the side.

FIG. 10.—Middle palmar space. Dissection made to show the injection mass lying in the space. The flexor tendons to the third, fourth and fifth fingers are shown reflected toward the fingers, while those of the index finger and thumb are drawn to the side. Note that toward the wrist the mass does not extend as far as the annular ligament.

FIG. 13.—Thenar spaces. Dissection to show the palmar thenar space. The tendons and lumbrical of the index finger are pulled aside. The floor of the space is the M. adductor pollicis. The outline of this space is shown by a dotted line.

FIG. 14.—Thenar spaces. Same dissection to show the dorsal and palmar thenar spaces. The thumb is drawn toward you and you are looking directly between it and the index finger. The adductor muscle is seen with the dorsal space on one side and the palmar on the other—these have been outlined by a dotted line.

ficial, and except where the tendons overlie, is covered only by the tough skin and dense fascia of the palm.

The distal boundary of the space—except for the lumbrical prolongations—is about at the level of the distal transverse crease of the palm. Here the space lies in close relationship to the proximal por-

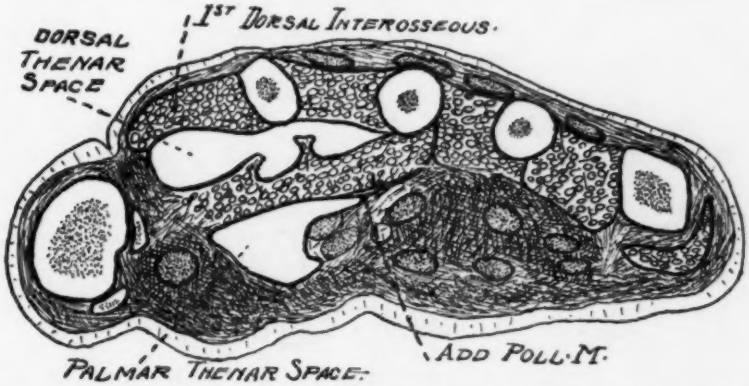

FIG. 12.—Thenar spaces. This cross-section gives a good idea of the relationship between the two thenar spaces and the M. adductor pollicis which separates them. Note the intimacy between the palmar space and the lumbrical muscle of the index finger.

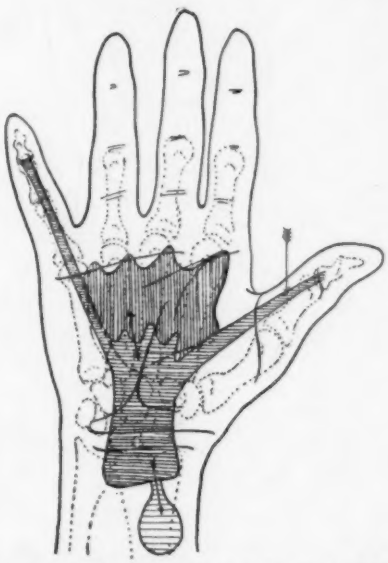

FIG. 15.—In this case the injection was made into the theca of the M. pollicis longus. The mass filled both the ulnar and radial bursæ and broke through the former, filling both the middle palmar and palmar thenar spaces. It also broke through the bursa at the wrist and infiltrated the cellular tissue between the muscle and the radius.

tions of the thecæ of the flexor tendons of the third and fourth fingers.

Extension of Infection beyond the Mid-palmar Space.—Because of the very intimate relationship between the mid-palmar space and the palmar thenar spaces, extension of infection from one to the other is of common occurrence where either has been primarily involved (Fig.

16). This is so frequently found clinically that any infection which has existed in the mid-palmar space for over forty-eight hours will in the majority of cases have extended to the palmar thenar. When both spaces are involved, there is produced an extensive abscess lying behind the flexor tendons and the pus is held under considerable tension.

In some cases in which the diagnosis of involvement of both spaces is made, one having been clearly primarily infected, at the time of operation it will be found that in the secondary space only a cloudy serum or a thin pus is obtained. In the primary space a different pus is present—thick and creamy. In these cases, either there is found in the space secondarily involved the so-called "protective pus" or

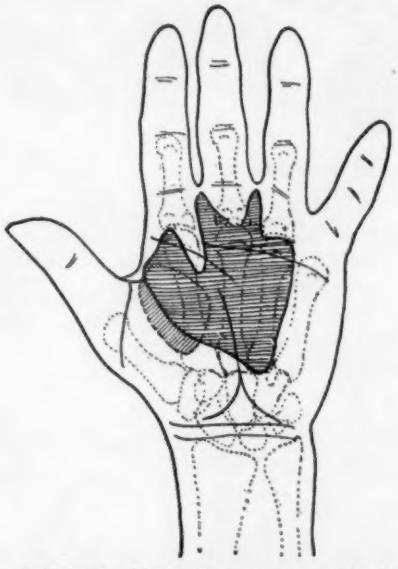

FIG. 16.—Injection made into the middle palmar space and rupturing into the palmar thenar space. From the latter it passed over the free margin of the adductor pollicis muscle in the web between the thumb and index finger to enter the dorsal thenar space. The latter is dotted. Note the marked prolongation along the lumbrical muscle of the middle finger, the injection mass extending to the web. Also, the middle palmar space reaches a point slightly above the distal limit of the annular ligament.

the infection has passed through the wall between the two spaces without destroying it. When the connective tissue wall is broken down, and this is what usually takes place, the rupture occurs in its proximal portion—judging from the injection mass experiments.

Infection not infrequently extends along one of the lumbrical prolongations of the mid-palmar space to involve the cellular tissue in the web between two of the fingers. The pus may point in the web, or in the palm proximal to it, and in some cases extends onto the dorsum of the hand.

In some cases, especially those of long standing, or those in which infection has occurred by a penetration wound into the space, the pus may present in the middle of the palm, burrowing its way at a level

distal to the ulnar bursa, between the tendons and through the dense palmar fascia and tough skin.

Involvement of the ulnar bursa also may occur, because of the intimate relationship between the space and this bursa. This is not so common, however, clinically or experimentally, as extension from this space into the palmar thenar space. Extension from the mid-palmar space into the wrist cannot occur without first rupturing into the ulnar bursa, because the space extends only to the level of the carpus. Above this level, the ulnar bursa is closely attached to the carpal arch.

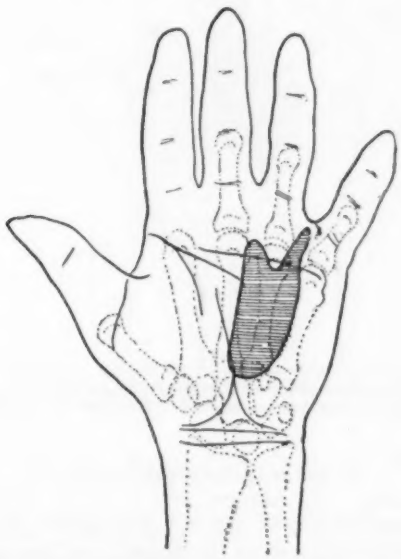

FIG. 17.—Injection made directly into the middle palmar space. In this case the mass passed up the lumbrical prolongation of the little finger and appeared at the web between this finger and the ring finger. Pus will sometimes take this course.

Rarely, the infection may burrow dorsally through the interossei muscles between the third and fourth or fourth and fifth metacarpal bones to appear on the dorsum of the hand, and in old neglected cases the involvement of the metacarpal bones must be mentioned.

Extension of Infection into the Space from other Structures.—As has been noted, the thecæ of the tendons of the third and fourth fingers are interrupted in the palm. When either of these becomes infected and the infection extends beyond the confines of the thecal sac, involvement of the mid-palmar space often takes place along the lumbrical prolongation related to the theca involved (Fig. 18). This relationship does not exist with the theca of the fifth finger, for it is continuous with the ulnar bursa—nor does it exist with the theca of the second finger which lies beyond the confines of the mid-palmar space.

Extension of a collar-button infection, *i.e.*, one involving the cellular tissue in the web between two fingers, may infect the mid-palmar space by extending along the lumbrical prolongation related to the web primarily infected.

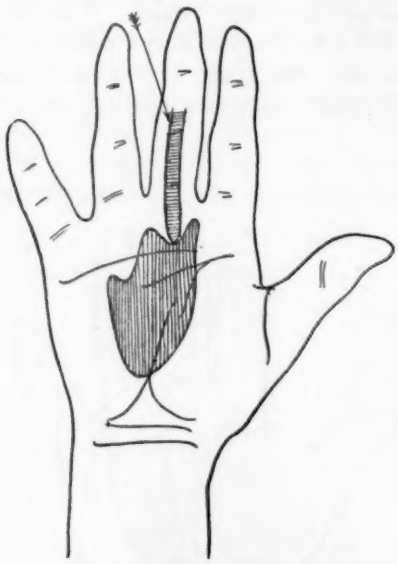

FIG. 18.—Injection made into the theca of the middle finger under considerable force passed beyond the theca and entered the middle palmar space.

V. PALMAR THENAR SPACE

This is a connective-tissue space[3] analogous to the mid-palmar space. It is a smaller space than the latter, and lies on the radial side of the middle metacarpal bone directly upon the M. adductor pollicis (Fig. 12). Medially its boundary is the thin connective-tissue membrane which extends from the tendon of the index finger to the origin of the adductor pollicis muscle, this membrane dividing the palmar thenar from the mid-palmar space.

Proximally the space extends not quite to the level of the annular ligament. On the radial side the space lies close to the flexor tendon to the thumb until that point is reached where the M. adductor pollicis passes under the flexor tendon. Here the boundary passes up toward the head of the second metacarpal bone until the lumbrical muscle of the index finger is reached. A prolongation of the space is continued along this lumbrical muscle for a short extent (Figs. 11 and 13). The distal level of the palmar thenar space is approximately the distal transverse crease of the palm.

The palmar thenar space is a deep one lying directly upon the fascia of the M. adductor pollicis which forms its posterior boundary. Anteriorly lie the flexor tendons and the lumbrical muscle to the

index finger—and to a small extent, that portion of the ulnar bursa which is related to these tendons. Between these tendons and the radial border of the space, the latter is covered only by the dense palmar fascia and skin.

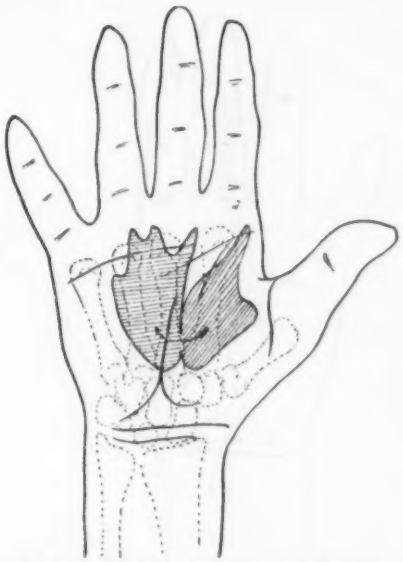

FIG. 19.—Injection made into the palmar thenar space passed from it into the middle palmar space, breaking through the fascial boundary which separates them, well toward the upper limits. The lumbrical prolongations are distinctly shown.

Extension of Infection Beyond The Palmar Thenar Space.—The most frequent point of extension beyond this space is into the mid-palmar space. This is commonly seen clinically (Fig. 19).

The next most frequent point of extension is into the dorsal thenar space which is separated from the palmar thenar only by the M. adductor pollicis. Extension may take place in one of two ways. The most common line of extension is to have the pus in the palmar thenar space burrow its way through the adductor muscle, finding a ready line of cleavage between the oblique and the transverse bellies, and thus pass directly into the dorsal thenar space (Figs. 11 and 20), or the pus may point toward the web between the thumb and index finger, and passing over the web margin of the M. adductor pollicis extend into the dorsal thenar space (Fig. 16). In some cases the pus will point in the palm directly over the space just to the radial side of the tendons of the index finger, without extending to the cellular tissue of the web, and without passing through the M. adductor pollicis to attack the dorsal thenar space.

Extension of infection may occur along the lumbrical muscle of the index finger, and present on the outer side of the finger or even involve the subcutaneous tissue on the dorsum of the first phalanx.

Involvement of the ulnar bursa or radial bursa is possible, but clinically this is very infrequent except in those cases in which the infection has first extended to the mid-palmar space.

When infection of the theca of the index finger occurs and extends

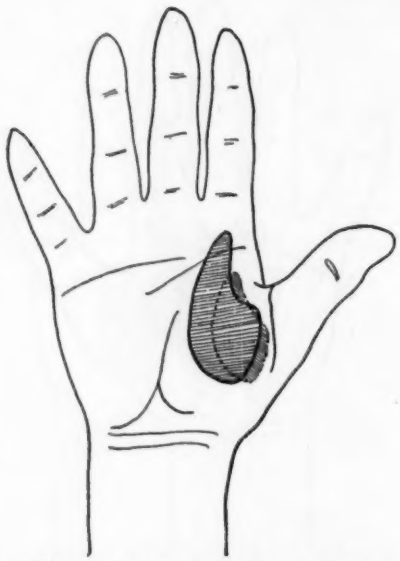

FIG. 20.—Injection made directly into the palmar thenar space. It passed through the adductor muscle and partially filled the dorsal thenar space which is shown by a dotted line. Here also is shown the characteristic extension of the palmar thenar space along the lumbrical muscle of the index finger.

beyond the confines of the theca, the palmar thenar space is very frequently involved, the extension taking place along the lumbrical prolongation which is intimately related to this theca (Fig. 21).

VI. DORSAL THENAR SPACE

This is definitely a connective-tissue space. It extends from the web between the thumb and index finger, ulnarward to the middle metacarpal bone. It is bounded in front by the M. adductor pollicis, and behind by the first and second interossei muscles and the second metacarpal bone. In the web between the thumb and index finger the space is superficial and is covered only by the subcutaneous tissue and skin (Fig. 14).

Its contents consist of a fairly loose connective tissue and the branch of the radial artery which, piercing the first dorsal interosseous muscle, courses through this dorsal thenar space to pass into the palm through the M. adductor pollicis. This space is separated from the palmar thenar only by the adductor muscle of the thumb.

Extension of infection beyond the confines of the dorsal thenar space occurs most frequently into the subcutaneous tissue of the web between the thumb and index finger.

Drainage instituted to relieve pus pointing here will often cause the infection to completely subside without the diagnosis of the extent of the infection into this deeper space having been made. The infection will sometimes extend through the M. adductor pollicis or

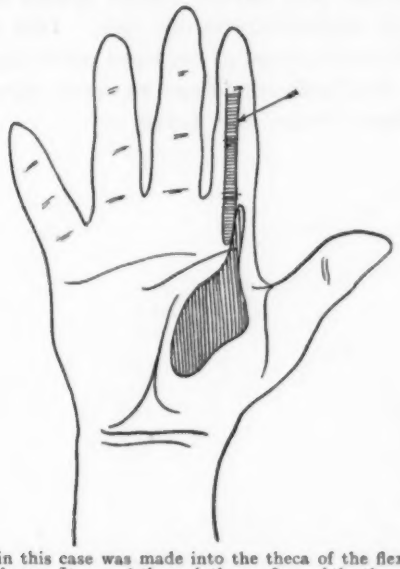

FIG. 21.—Injection in this case was made into the theca of the flexor tendons to the index finger under considerable force. It passed through the confines of the theca and entered the palmar thenar space at the lumbrical extension of the space.

over its free margin, to involve the palmar thenar space. Infrequently infection in the dorsal thenar space extends through the first dorsal interosseus muscle and appears on the dorsum of the hand.

VII. POINTS TO BE EMPHASIZED

1. The radial and ulnar bursæ lie completely behind the flexor tendons in the wrist, and extension of infection at this level tends to produce deep cellulitis of the forearm and involvement of the wrist joint.

2. Under the annular ligament these bursæ lie partially anterior to the flexor tendons. Infections tend to point on the anterior surface of the wrist proximal to the ligament as well as into the carpal joints.

3. The nerve supply to several of the thenar muscles crosses the radial bursa in the region of the distal border of the annular ligament.

4. Intimate relationship between the bursæ and the deep spaces of the palm.

5. Mid-palmar space does not extend proximal to the distal level of the annular ligament. Infection extending toward the wrist from this space must involve the ulnar bursa.

6. Intimate relation between the mid-palmar and palmar thenar spaces—the boundary between them being a thin wall of connective tissue.

7. Relationship between the theca of the index finger and the lumbrical extension of the palmar thenar space. Similar relationship between the thecæ of the middle and ring fingers and the lumbrical extensions of the mid-palmar space.

8. The mid-palmar and palmar thenar spaces may be true bursæ as has been shown conclusively in one case. This should be borne in mind in dealing with affections of the hand other than acute infections. It is conceivable that such conditions as acute traumatic bursitis and tuberculosis of these bursæ may occur.

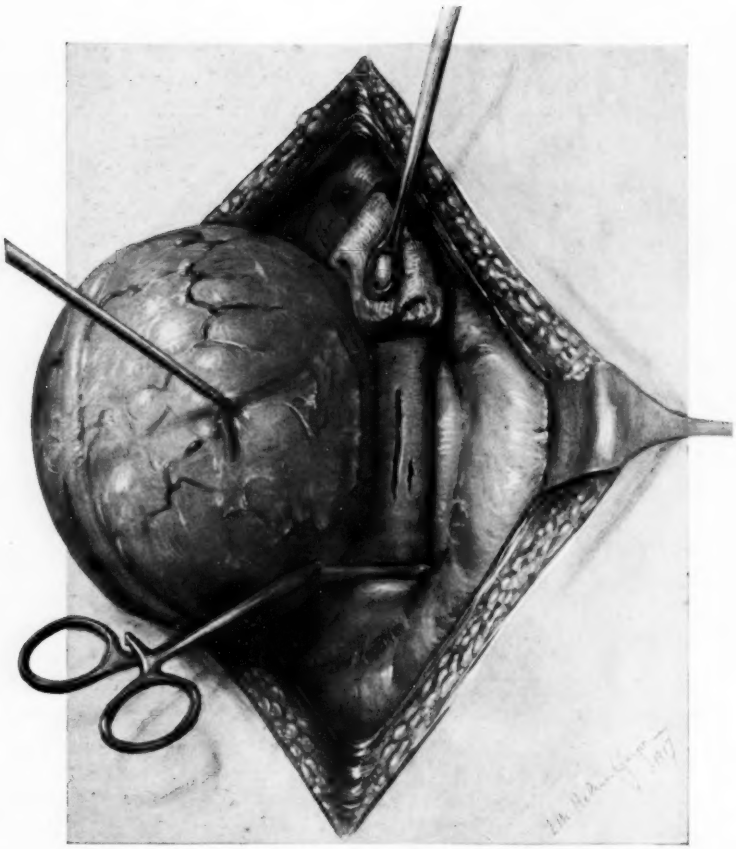

FIG. 1.—Ascending vena cava wounded in the removal of a retroperitoneal mixed-cell sarcoma Note clamp placed on lower portion of inferior vena cava. Note ureter deflected over tumor mass.

LACERATION OF THE INFERIOR VENA CAVA: REPAIRED BY SUTURE: RECOVERY

By Herbert P. Cole, M.D.

of Mobile, Ala.

An investigation of surgical literature discloses very few instances of extensive laceration of the inferior vena cava with recovery. My experience with a recent grave injury of such a nature prompts me to present it to the profession.

On December 6, 1916, I operated a thirteen-year-old negro, referred by Dr. Samuel Alman of Gilbertown, Alabama. The patient presented a rapidly growing tumor mass bulging in the upper right quadrant of the abdomen. At operation a globular tumor mass 12 x 19 cm. was found in the retroperitoneal space.

After incising the retroperitoneal tissues, the ascending and transverse colon were easily displaced outward and upward. The ureter deflected over the most prominent portion of the tumor was dissected from the tumor mass and displaced outward without great difficulty. Quite firm capsule-like adhesions fixed the tumor to the lower thoracic vertebræ, and a quite definite thickened peduncle originated from the right side of the twelfth thoracic vertebra. The tumor mass forced the inferior vena cava and aorta quite markedly to the left of the spinal vertebræ.

While separating the dense capsule-like adhesions from the large vessels, we produced two longitudinal rents in the anterior surface of the inferior vena cava, one about 3½ cm. and the other about 1 cm. in length. A very profuse hemorrhage was controlled temporarily by a gauze pack. The first efforts to disclose the nature of the hemorrhage were unsuccessful. The pack was finally held firmly compressed by the assistant's hand, and the tumor rapidly removed as the patient was almost exsanguinated.

The vena cava was finally exposed sufficiently to allow an ordinary serrated Pean type clamp to be placed upon the vena cava below the rent, a gauze sponge on a sponge holder controlling some slight oozing from above. Both lacerations were quickly whipped over with a single stitch of fine catgut on a fine needle. Upon removing the clamp and sponge there was very little oozing. The entire cavity was rather loosely packed with iodoform gauze and the retroperitoneal edges were stitched to the anterior peritoneal wall. The patient was pulseless at the end of operation, but was carried through a quite exciting twenty-four hours with intravenous saline, and was discharged from the hospital within three weeks with the abdominal wound practically healed.

In consideration of our necessarily rough handling of the inferior vena cava we were not disappointed in anticipating vascular disturbances. Ten days after the operation the patient developed a quite extensive œdema of his entire right leg. This persisted for several days but gradually disappeared by the tenth day.

Up to the present time, now about two months since operation, the patient has had no further complications.

INTRAPERICARDIAL TRAUMATIC HEMORRHAGE

TWO UNUSUAL EXPERIENCES IN HEART AND PERICARDIAL SURGERY

By Goodrich B. Rhodes, M.D.

of Cincinnati, Ohio

ATTENDING SURGEON, CINCINNATI GENERAL HOSPITAL; JUNIOR ATTENDING SURGEON EPISCOPAL HOSPITAL FOR CHILDREN.

Penetrating wounds of the heart or pericardium which are seen in civil surgery are rarely observed upon the operating table, for the surgeon is usually indebted to the fact that he happens to be present when the case is brought in for the chance to operate. This was my good fortune in both these cases. Even in the vast operative experience furnished by the present war there are very few cases reported of operative attack upon the heart or pericardium. In fact, after a rather cursory review of the available reports I was able to find only two, one a case of suppurative pericarditis, operated on some weeks after the injury, and one fatal case of heart perforation. Therefore I feel very little hesitancy in presenting these two cases from the Cincinnati General Hospital service, for each presents certain interesting points in diagnosis and treatment, and one in especial shows a clinical condition of the most extreme rarity.

In general it may be said that very few traumatic lesions of the thorax demand operative relief. The more we keep our hands off the average gunshot wound, stab wound or other injuries the brighter are our patients' chances of dying of old age. But there is a definite type of thoracic injury in which interference must be prompt, and no considerations such as the critical condition of the patient must interfere with such operative attack. The lesion to which I refer is acute hemorrhage of large amount into the pericardial sac, accompanied by very slight opportunity for the free outlet of the hemorrhage. This will be shown in both of these cases.

Case I.—*Stab wound of pericardium; intrapericardial hemorrhage.* A negro laborer, aged twenty-seven years, was admitted to the East Surgical Service of Dr. Frank Fee, who kindly allowed me to operate. Examination showed a stab wound about an inch in length, parallel to the sternum and about an inch from its left border. This wound passed through the fourth left costal cartilage, which was completely severed. The instrument used was the large blade of a pocket knife, which was declared to have been driven in its entire length. The wound was bleeding freely at first, but later the flow was not as free, as the opening became plugged by blood-clot. The man was in dyspnœa, which increased in degree, and there were hyperresonance and very faint breath sounds over the entire left chest, leading to the diagnosis of pneumothorax. The area of cardiac dulness was greatly in-

creased, but was slightly more to the right than normal, had a flat note, and the heart sounds were barely audible. There was slight cyanosis of the lips which increased perceptibly. The physical signs were correctly interpreted to mean hemorrhage into the pericardium, but the cyanosis and dyspnœa were construed to be caused by the pneumothorax. The operation showed this to be incorrect. His pulse was 100 and not very good, but was regular. Respirations were 28 and temperature was normal.

From the location of the wound it was difficult to understand how the heart could have escaped puncture, so with the physical signs of fluid in the pericardium, the muffled heart sounds and the character of the pulse, I made the tentative diagnosis of stab-wound of the heart, and operated immediately.

Ether anæsthesia, drop method. Benzine and iodine skin preparation over chest. A rectangular osteoplastic flap was then made in the following manner. An incision was made over the middle of the sternum, extending from the second to the fifth costal cartilages. From the upper and lower ends of this incisions were made at right angles to it for a distance of five inches. This skin and muscle flap was dissected back and the cartilages of the third and fifth ribs were divided subperichondrially. The fourth was already divided by the injury. The intercostal spaces were then incised and the whole osteoplastic flap bent backwards, breaking the ribs. This was done with very little force and I judge the fractures occurred at the junction of the cartilage and rib. The internal mammary artery was ligated.

This gave splendid access to the anterior mediastinum. The triangularis sterni was incised and pushed aside, and the pleura was seen to lie very close to the left sternal margin, and the rent was seen where the knife had perforated. This rent and the underlying tear in the pericardium were as wide as the external wound, so the knife must have gone in up to its widest part. Consequently, we fully expected to find the heart perforated. The pericardium was now grasped with forceps and opened in the long axis of the heart. A tremendous gush of blood came out, apparently under tension. The condition of the patient improved remarkably, the respirations and pulse improved and the cyanosis lessened greatly. I now realized that I had been dealing with a case of heart tamponade, and that the respiratory symptoms, poor pulse and cyanosis were due to that and not to the pneumothorax.

The heart was now inspected and no stab wound was present, but the source of hemorrhage was seen to be quite a large pericardial vessel. This was ligated and the field remained dry.

The interesting feature of the case was now seen. The heart and its movements were now studied to ascertain how it had escaped puncture, and the following condition was evident. The heart in diastole lay close to the thoracic wall and overlapped the wound of entrance by fully two inches. In extreme systole, however, the extreme left border of the heart lay about one inch

to the right of the perforation. In other words, the knife must have gone in during systole and just missed the heart. In diastole it would certainly have been caught. It must be remembered, also, that at the time he was stabbed the heart lay further to the left than when we saw it, for the pneumothorax pushed it to the right.

The pericardium was sutured with continuous suture of catgut, previously washing out the sac with salt solution. No drainage was used. The osteoplastic flap was pushed back into place and was held by a few sutures placed in the perichondrium and fascia. Skin flap sutured with silkworm gut. He left the operating table in good condition.

The next day the breath sounds were weak over the collapsed lung, but were audible over entire chest. Heart action regular.

Three days later the breath sounds were normal. Apex beat in fifth interspace. Temperature normal. He left the hospital nineteen days after admission, with a perfect cosmetic result. Union was prompt and no deformity or irregularity of the chest was perceptible. Heart and lung action were normal.

CASE II.—*Stab wound of pericardium and right ventricle; intrapericardial hemorrhage; unsuccessful attempt at heart suture.* This case, although terminating fatally, certainly deserves to be reported. After a very thorough search of the literature of cardiac surgery I have not encountered a similar condition, and I am glad to have the coroner's report of the post-mortem to substantiate my own unsupported statement.

S. W., colored, aged thirty years, was stabbed in the chest shortly before admission. He entered the South Surgical service of Dr. C. E. Caldwell, to whom I am indebted for the privilege of operating. I saw the man when he was brought to the hospital and had him transferred immediately to the operating room after a hurried examination. Patient was almost moribund on admission, and he presented a stab wound to the left of the sternum at the sixth interspace. He had lost a large amount of blood, but this hemorrhage had ceased when the wound was packed in the receiving ward. He presented a picture similar to the last case, but was in much worse condition. His pulse was very bad, heart sounds were inaudible over the precardium, there were the physical signs of fluid in the pericardium, but the area of flatness was much further to the right than normal, due to the accompanying pneumothorax, which was very pronounced. Dyspnœa was present, but not of very great severity. There was slight cyanosis of the lips.

Operation was performed about ten minutes later. The same incision of the pericardium liberated a gush of blood and, as before, the condition of the patient improved to a great extent. The heart was now inspected and no perforation was seen on the presenting surface.

The hemorrhage, however, continued, and kept the pericardial sac fairly full in spite of sponging, and the pericardium itself was

inspected for the bleeding vessel. None was discovered, so the heart was lifted out of the pericardial sac and then the true state of affairs was disclosed. My fingers felt a roughened area on the posterior aspect of the heart, and on closer inspection of the heart itself, the part presenting anteriorly was seen not to be the right, but the left ventricle. The rough area on the posterior aspect of the heart was situated then in the right ventricle. The hemorrhage was coming from this wound, but how the wound could be situated on the posterior aspect of the heart, leaving the front untouched, was more than I could figure out at the time. However, as the patient's condition was very bad, I tried to sew up the perforation, but found that every attempt to lift up the heart to expose the posterior aspect was followed by a stopping of the cardiac pulsation. A similar result was produced when the heart was rotated. An attempt was now made to pass the suture without seeing the perforation, guiding the needle by a finger held against the opening. This was found to be impossible, as the space between the pericardium and the heart posteriorly was too narrow, and the constant motion of the heart itself baffled any attempt to place a suture unguided by the eye. One who has never seen the movements of the heart in the living body has little conception of the wide excursions that it makes, and the great difference in size the heart shows in extreme systole and greatest diastole, and the accurate placing of the suture was found to be impossible without lacerating the heart wall still further. The pericardium was then packed with gauze and the patient removed from the table, as he was moribund, death occurring half an hour later.

The postmortem by Dr. Coe disclosed a curious and interesting condition. The heart was seen to be rotated on the longitudinal axis, so that the right ventricle presented posteriorly, and showed a perforation about one-half inch long extending into the cavity of the ventricle. The left ventricle formed the anterior aspect of the heart, and the heart was dislocated slightly to the right. A pneumothorax was present. There was no other wound of the heart, and the only explanation which I can offer is that after the heart was perforated the pneumothorax not only pushed the heart to the right, but rotated it on its axis, swinging it over as a hinged door changes the relation of its surfaces to the room into which it opens.

In the last year or two I have had occasion to make a very thorough review of the literature of the surgery of the heart, and I have nowhere encountered a similar experience.

A critical review of these two cases has led me to the following conclusions. The method employed in forming the osteomuscular flap, while giving a splendid exposure of the operative field, necessitated fracturing the ribs. This in itself does no harm, but should only

be practised in those cases in which a left pneumothorax can be definitely diagnosed, for the danger of tearing the pleura is very great. It did not occur in either of these cases, but the possibility of its happening should be borne in mind. The after-results of the method, as shown in the case which recovered, have left nothing to be desired. Union occurred promptly, was firm, and no deformity resulted. Subperiosteal division of the ribs would theoretically be more desirable than fracture, but it consumes time, and time is one of the first considerations in this operation, for the sooner the heart is relieved of the intrapericardial pressure the brighter are the chances of success. Both these cases showed definite symptoms of heightened intrapericardial pressure, which were before operation attributed to the pneumothorax. That this was an error was conclusively demonstrated when the pericardium was incised, for an instantaneous and pronounced change for the better was observed in the respiration, cyanosis and character of the pulse. I have reported a similar experience, even more pronounced, in a case of suppurative pericarditis with a very irregular pulse. This irregularity disappeared suddenly and permanently when I incised the pericardium, thus relieving the pressure.

Both of these patients received ether by the drop method, and no difficulties were experienced in its use. The intratracheal method might be employed with great advantage here, and has been used in a recently reported case from the war zone; but we must not overlook the main factor which is producing the gravity of the symptoms in these cases, namely the heart tamponade, in which the intrapericardial pressure is in the excess of intra-auricular pressure. Consequently the sooner this is relieved the better will be the condition of the patient. The almost certain complication (in stab wounds) of a pneumothorax renders it very easy to attribute the profound respiratory disturbance to this and to overlook the cardiac condition which is really the cause. As I have shown in a recent paper it is extremely difficult to aspirate the pericardium without going through the pleura, therefore a stab wound will almost certainly damage it, and usually produce a pneumothorax.

Whether to close the pericardium or to drain it after these operations is still a matter of opinion. Certain it is, however, that a great number of the cases in which no drainage was used have recovered with no complications. I am further convinced, moreover, that the adhesions which must result from the use of a drain are a more certain evil than the merely possible occurrence of infection, which can be handled in an appropriate manner if the necessity should arise.

The following conclusions may therefore be drawn:

1. There is practically in all cases of stab wound of the heart an accompanying injury to the pleura, usually resulting in pneumothorax.

2. Extreme symptoms of respiratory embarrassment should be considered as caused by the heart tamponade, and not by the pneumothorax alone.

3. This tamponade must be relieved immediately.

4. These cases stand ether anæsthesia well.

5. The incision used in these cases gives splendid access to the heart and gives perfect functional and cosmetic results.

6. Drainage is not necessary, but the sac should be washed out before closing, preferably with salt solution.

SUBCUTANEOUS INJURIES OF THE LIVER

A REPORT OF TEN CASES

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The liver, due to its position between the bony thoracic walls and to its almost complete fixation and slight elasticity, is particularly prone to be injured by many varying forms of violence. Ten cases of liver injury have come under the writer's care since January, 1908. Of these, nine cases were submitted to operation with two deaths. One was not recognized as a case of liver rupture except at the autopsy. Of the above ten cases one was a subcapsular hæmatoma, one a large hemorrhagic cyst, and the other eight were lacerations of the liver of varying degrees.

Rupture of the liver may occur spontaneously in carcinoma of that organ (Chiari)[1] or following pneumonia with pleurisy and pericarditis (Heinzleman);[1] but in the large majority of cases it is due to some form of trauma either as a result of direct violence over the liver proper, or by some form of indirect violence, such as a fall upon the feet, the head, or a blow on the left side.

Two varieties of liver rupture are recognized by Terrier and Auvray:[2] (1) those in which the capsule of the liver is untorn, the injury being subcapsular, and (2) those in which both capsule and parenchyma are torn.

In the first we may have subcapsular hæmatoma due to the rupture of the small vessels between the capsule and the parenchyma with or without a rupture extending into the parenchyma; or there may be small hemorrhages deep in the parenchyma which do not appear on the surface (hepatic apoplexies). The latter may form a cyst or cysts of varying sizes, the blood remaining fluid for some time; or the hæmatoma may become infected and form single or multiple abscesses. Of my cases, Case I represents the type of subcapsular hæmatoma; Case II that of a subcapsular hæmatoma of some size forming a blood cyst which amounted to 82 ounces in an aspirating bottle.

The second group includes small shallow tears through the capsule into the parenchyma up to the complete severance of large portions or even an entire lobe of the liver.

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[1] Quoted by Fraenkel, Beit. z. klin. Chir., 1901, Bd. 30, p. 418.
[2] Revue de chir., 1896, No. 10, 1897, No. 1.

Of the cases reported here all involved the right lobe; five involved the concave; two the convex; and one extended through the free edge on to both concave and convex surfaces. In two the tears completely severed the right lobe (one case still had a portion of the parenchyma and capsule on its anterior surface, but for all practical purposes it completely detached a large portion of the right lobe); while the remainder were larger or smaller rents extending to varying depths into the liver substance. The two extensive cases died; all the tears of lesser magnitude submitted to operation recovered.

Rupture in this series occurs most frequently on the concave surface of the liver and less frequently on the convex side. The right lobe was more commonly involved than the left.

Edler [3] states very aptly that the danger lies not so much in the injury to the liver as in its results and their complications, namely, hemorrhage, infection, peritonitis, ileus, death due to the escape of large quantities of bile, the forcing of the liver tissue into the veins forming emboli which localize in the lung capillaries (Marshall, Hess, and Zenker); or which localize in the entrance of the inferior vena cava into the heart (Schmorl).[4] Escape of bile into the peritoneal cavity or the loss of large quantities of bile causes death, as shown by Laehr, Postemski, Morris.[4]

Of the results of liver rupture hemorrhage is the most serious. In Fraenkel's statistics death resulted 69 times before twenty-four hours, and in 81 cases inside of forty-eight hours.

Of my cases, one, the unrecognized case, died from hemorrhage from three small tears in the liver on the convex surface of the right lobe, within twenty-four hours, and no other cause for death could be found at autopsy. In Case VI, in which the whole right lobe external to the gall-bladder fissure was separated from the liver, the child died from hemorrhage while the wound was being closed; and in Case IV death resulted from the effects of the hemorrhage twelve hours after the injury, although further hemorrhage did not occur after the operation.

Tillman [5] reports a case in which at autopsy three days after injury a large piece of liver was found torn from the surrounding liver tissue. The defect in the liver was found filled with blood clot, but no blood was found in the peritoneal cavity. He concludes that one only finds large amounts of blood if a large vessel is torn, a statement which Case X, in which the tears were shallow and showed no torn vessel of any size at autopsy, and Case V, in which the tear while long was quite shallow, but in both of which the belly was filled with blood, would tend to contradict.

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[3] Quoted by Fraenkel, loc. cit.
[4] Quoted by Fraenkel, loc. cit.
[5] Virch. Archiv, Bd. 78, Hft. 3.

Terrier and Auvray [6] consider the blood-vessels of any size as more resistant to injury than the liver tissue. The bleeding depends upon the physiological hyperæmia or anæmia of the organ. Podwyssozki [7] found, for example, that in animals deprived of food for from one to two days the liver became anæmic and contracted, and in such cases there was little bleeding from the cut liver surface. The amount of the hemorrhage depends upon the location of the tear, the hemorrhage being freer from the concave surface. The tear heals by scar tissue chiefly with some formation of new gall-ducts and undeveloped liver tissue (Ziegler).[8]

The symptoms of liver injury usually given include many phenomena. Since my cases represent a consecutive series only those which occurred in the series will be mentioned, with such reference to the missing ones as may give a clear understanding of the symptom complex.

Only nine of the cases here reported can be used for analysis, as Case II represents a later stage of one of the types of liver injury and no direct information of the conditions existing after the accident was obtainable.

Shock was present as an immediate symptom in all except one of the cases, *i.e.*, Case VIII, which came to the hospital between four and five hours after the injury. In the other cases shock was stated as profound in one, very severe in five, and extreme in two, who were unconscious upon admission.

Thöle [9] describes a variety of shock which appears at the end of three or four hours as a result of hemorrhage, *i.e.*, a delayed onset of the shock. This was not present in my cases. In Case VIII, in which shock is specifically mentioned as absent, a statement is made that the boy "does not look sick."

The pulse was small, rapid, barely felt at the wrist in four cases, the patient pulseless in five cases, in one of which the heart sounds are mentioned as barely perceptible with the ear upon the chest. Bradycardia, described by Finisterre [10] as a diagnostic sign, did not occur in this series. The temperature was subnormal, 97° F. in three cases; normal, 98.6° in four cases; 99° in two cases. The respiration was rapid, shallow, gasping in character, and costal in type in eight cases.

Signs of Hemorrhage.—The statement that the patient was pale, eyes sunken, extremities cold, appears in practically all the cases. The essential feature of this symptom is, however, the presence of dulness in the abdomen. This is mentioned as absent in two cases. In Case I this observation was correct. In Case X it was obviously an error in

[6] Rev. de chir., 1896, No. 10, 1897, No. 1.
[7] Quoted by Fraenkel, loc. cit.
[8] Lehrbuch d. path. anat., 1898.
[9] Neue Deutsch. chir., Bd. 4, 1912.
[10] Deutsch. Zeit. f. chir., Bd. 121, 1913, p. 520.

observation, as the abdomen was full of blood at the autopsy. Dulness was stated as being present in both flanks and movable in six cases. In one case dulness was found in the right flank, which was not movable, a correct observation, as the quantity of blood in the cavity was not large and most of it was confined to the right flank (see Case VIII). The liver dulness was stated to be normal or unchanged in six cases. In one it was mentioned as being diminished, and in two no mention was made of it.

Vomiting as an early symptom was mentioned as having occurred in four cases and was not mentioned in the remainder. It was not copious and contained only the stomach contents.

The Character of the Abdomen.—The abdomen was stated to be flat or retracted in eight cases, distended or full in one case. Total rigidity of the abdomen occurred in eight cases. In one case the rigidity was present in the upper half and the lower abdomen was soft. Tenderness was noted as most marked over the whole abdomen in five cases, over the right upper half of the abdomen in two cases, over the right upper rectus in two cases.

Pain was noted as a marked symptom in all except the two cases which were unconscious (Cases III and X). Referred pain was noted in three cases (Cases VII, VIII and IX), and in these cases was referred to the upper right scapular region. Bimanual pressure over the liver region increased this pain. It is interesting to note that the location of the liver rupture differed in all three of these cases. In one the laceration was on the concave surface of the right lobe running from behind forward; in one the liver tear involved the free edge of the right lobe well down into the flank and extended an equal distance upon the convex and concave surfaces; and in the third the lesion consisted in multiple tears upon the convex surface of the right lobe about four fingers' breadth from the free edge.

Jaundice did not occur as an early or late symptom in this series. Edler states that jaundice may appear as a primary jaundice two, three, or four days after the injury, as an absorption jaundice from the bile in the peritoneal cavity, or later as a secondary jaundice as a result of hepatitis, liver abscess, etc. One of the cases in this series developed a subdiaphragmatic abscess during his convalescence, but at no time did he show any evidence of jaundice.

The urinary findings in this series are chiefly post-operative ones and show nothing of any significance. Bile was not present in any of the specimens examined.

The blood examinations are not recorded in four of the cases. They were doubtless made, but being emergency cases were not immediately recorded, and hence probably forgotten later. The other cases show nothing of any moment except the early increase in the leucocyte

count, which was highest in Case IX, submitted to operation about six hours after the injury.

Hæmoglobin	Leucocytes	Differential
..	12,000	..
95 per cent.	10,000	77 per cent.
..	24,000	84 per cent.
..	50,000	89 per cent.

The diagnosis of liver rupture offers many difficulties. Didactically it is easy to differentiate between a superficial contusion of the abdomen and an internal injury, but practically it is quite difficult to determine the nature of a given abdominal injury at that early stage which renders operative interference of value, as Madelung [11] has pointed out.

The evidences of a liver injury are those of a severe internal injury and may be considered as presumptive and positive. Under the presumptive evidence one must consider the nature, force, and site of application of the violence. The passage of a heavy vehicle over the upper part of the abdomen (Cases I and IV); a kick in the upper abdomen by a horse (Cases III and IX); a fall from a height striking on the right side against a fire escape, chair, etc. (Cases V and VII); a severe blow over the right hypochondrium (Cases II and VI) should be sufficient suggestion that one might expect some severe internal injury.

The presence of a local superficial contusion, if it means anything, is usually negative evidence. There were no signs of superficial injuries in any of my cases. In children especially the clothes are more trustworthy than the evidence of bystanders, and will show in most cases the mark of a horse's hoof (Case III), or the mark of wheels (Cases I and IV).

Under the more or less positive evidence of severe internal injury due to liver injury are shock, which is usually profound; signs of hemorrhage as evidenced by skin pallor, an early leucocytosis, and dulness in the flank; pain in the abdomen with tenderness, and on bimanual pressure over the liver with radiation of the pain to the right shoulder and rigidity of the abdominal muscles, especially over the upper recti. The abdomen is flat, the respiration shallow and costal in type.

The early hæmoglobin estimations do not, as a rule, show any marked change. In fact, a number of hours must pass before any change becomes definite and a lowered hæmoglobin estimation is not a dependable symptom.

Given presumptive evidence sufficient to consider internal injury a factor in the case when our positive evidence is meagre or unsatisfactory, the treatment should be prompt surgical intervention. Delay avails nothing. If there is no injury, or if it is merely a subcapsular hæmatoma, recovery occurs. If a liver rupture is present and the ab-

[11] Zeit. f. klin. chir., Bd. 17.

domen is full of blood, recovery depends upon the extent of the liver injury and the time of surgical intervention. Late operations have a much higher mortality. Thöle's [12] statistics with regard to this fact are illuminating. He divides the time of operation into four periods: First period, up to six hours after injury, gave 39.5 per cent. mortality; second period, seven to twelve hours after injury, gave 50.4 per cent. mortality; third period, thirteen to twenty-four hours after injury, gave 66.6 per cent. mortality; fourth period, later than twenty-four hours after injury, gave 86.3 per cent. mortality.

For prognostic purposes cases of liver injury must be divided into three groups: First, the subcapsular injuries which recover unless complicated by infection or by cyst formation when the prognosis becomes that of those conditions. Second, injuries extending through the capsule into the parenchyma. Here we find one group (*a*) in which the liver is torn in half and a large fragment separated from the remaining liver tissue, which type is invariably fatal; another group (*b*) in which the prognosis is so intimately connected with the time of operation that one might fairly say that those cases operated upon early nearly all recover and all others die. Third, that group of cases in which other viscera and the liver are injured, which cases are more serious and have a higher mortality.

Edler,[13] in a statistical study of non-operated cases, the diagnosis being clinical, found that death occurred in 78.2 per cent. of the cases uncomplicated by other visceral injury. Douglas, in the complicated cases submitted to operation, collected from the literature, puts the mortality at 41.4 per cent., but believes that the true mortality is somewhat higher. Fraenkel [14] reports two cases of his own and twenty-nine cases from the literature submitted to operation within the first three days. Of these seventeen were cured, fourteen died. Of the fourteen fatal cases ten were complicated by injury to other organs, and, if we eliminate these, we have a percentage mortality of 19 per cent. plus and recovery in 80 per cent.

Statistical studies which do not specify the extent of the liver injury and the time of operation can give but little light upon the real results of liver injury. Of the nine cases in this series submitted to operation, seven recovered and two died, a mortality of 28.5 per cent. for the series. Submitting these cases to further analysis two are found in the first group above mentioned, *i.e.*, the subcapsular injuries. Case I would undoubtedly have recovered without operation, and Case II represents the after-effects of a subcapsular hemorrhage of four months' duration. The cases are not sufficient for this type to give any real insight into the mortality for this type.

[12] Neue Deutsch. chir., Bd. 4, Stuttgart, 1912.
[13] *Loc. cit.*
[14] *Loc. cit.*

Eight cases are found in the second group above mentioned, *i.e.*, tears of the capsule and parenchyma. Seven were submitted to operation and one passed unrecognized as a liver rupture until the autopsy. Further analysis shows that these seven operative cases should be divided into two groups discussed in the earlier portion of the paper, viz.:

(*A*) Severe liver injury separating a large portion of the liver more or less completely:

Two cases. Operation within an hour after injury with two deaths. Mortality 100 per cent.

(*B*) Liver lacerations of varying degrees extending into the liver substance for varying depths.

Five cases, five operations. Two cases one hour after injury. One case three and a half hours after injury. Two cases within six hours after injury. Five recoveries.

The unrecognized case would come into this group and gives a hundred per cent. mortality for non-operative interference for the group.

Thöle's [15] statistics for 260 cases of subcutaneous liver rupture submitted to operation are as follows:

1.—Simple liver rupture, 188 cases with 83 recoveries and 105 deaths, a percentage mortality of 55.85 per cent.

2.—Complicated liver injuries. In this group he includes both severe liver injuries as well as injuries to other viscera, which rather confuses the issue. He reports 59 cases with 14 recoveries and 44 deaths, a percentage mortality of 74.6 per cent. for one subdivision. Under his subdivision (*b*), which includes small liver injuries with severe injuries to other viscera, he reports 14 cases with 3 recoveries and 11 deaths, a percentage mortality of 78.6 per cent.

It is difficult to establish a basis of comparison in the face of these varying methods of classification. Practically all his cases grouped under his second subdivision I would group under my Group 3, and would expect a very high mortality for this group because of the rapidity of the hemorrhage.

With regard to the treatment of the liver injury proper, many methods for arresting hepatic hemorrhage have been advised, viz., packing, suture, the actual cautery, steam, digital compression of the liver hilus (Tuffier), compression of the ligamentum hepatoduodenale by a special clamp (Baron),[16] etc.

In the cases reported here there was no active hemorrhage at the time of operation which could not be stopped by packing the liver wound with a long-tailed cigarette gauze drain, which was then brought out through a stab wound in the abdominal wall directly over the liver

[15] *Loc. cit.*

[16] Zentralbl. f. klin. chir., No. 49, 1910, p. 1547.

wound. The drain was left in place until it became loose, about the seventh day, when it was gradually shortened day by day, until it was removed. Suture would not have been practical in any of my cases, since the abdominal incision and the liver wound were not so situated, the one to the other, as to render suture possible, except under time-consuming difficulties. In Case VIII a piece of omentum was used to plug the rent in the liver, which was not large, and the hemorrhage was completely stopped by this means.

With the other forms of treatment for liver lacerations the writer has had no experience, inasmuch as gauze packing was sufficient for all the cases under the writer's care, except the one in which the omentum was used. The rapidity with which the gauze can be inserted is also a matter of some importance, since patients with liver injury do not bear any long-continued operative procedure due to the collapse following the rapid bleeding from the torn liver surface.

The post-operative course is usually stormy. Ileus and pain have been prominent symptoms in this series, both of which were relieved by enemata and by an electrical pad placed over the abdomen. One case developed a supradiaphragmatic abscess due probably to the blood which was not removed at the first operation, and this abscess was subsequently opened and drained and the patient made a very satisfactory recovery. In all of the cases at the New York Hospital the fluid blood was removed by the Kenyon-Pool aspirating device by an assistant while the exploration and treatment of the liver wound was being handled by the operator. This suction device lessens the time of operation, makes the traumatism less, due to the ease with which the blood can be sucked out of the abdomen, and, due to the more complete removal of the blood, decreases the amount of the post-operative reaction which results from any quantity of blood left in the abdomen. It will be noticed in the case reports that saline irrigation was practised in the earlier cases and the belly filled with saline solution during the closure of the abdomen. This was abandoned as an unnecessary procedure when it was observed that patients with hemorrhage from other conditions who had not been irrigated, etc., had a less uncomfortable and less stormy convalescence.

TYPE I. SUBCAPSULAR INJURIES

CASE I.—Stephen G., aged seven, admitted to Bellevue Hospital (Second Surgical (Cornell) Division) April 26, 1909, with a history of having been run over by a delivery wagon just previous to admission. There were marks of wheels on the clothes just over the abdomen. The patient was pale, pulse small, barely felt at the wrist, respiration rapid and shallow. Temperature 98.6° F. Extremities cold. Abdomen flat and rigid, tenderness most marked over the upper right rectus. No dulness in flanks.

Operation one-half hour after the injury. Median gastric incision. No blood in cavity. Subcapsular hæmatoma on the convex surface of the liver just to the right of the falciform ligament. Measures 6 inches by 1 inch. Tier closure of abdomen. Reported well and without symptoms six months after the injury.

CASE II.—Wm. G. M., aged thirty-two, admitted to the New York Hospital (Dr. Conner's Service) December 3, 1908. He complained of swelling in the upper abdomen, weakness, pain in the abdomen radiating to the left side and into the back below the left shoulder blade, and blood in the stools.

The present illness began about four months before admission (July, 1908). The patient while at work was struck a severe blow upon the stomach by a truck stay. Following the blow he was nauseated, felt weak, and had severe abdominal pain, for which he consumed large quantities of whiskey. He was unable to work, as the pain was aggravated by moving, coughing, vomiting, or deep breathing. About two months after the injury the pain became more intense, was localized definitely in the epigastrium, and the patient could neither lie down nor sleep. Early in October, about three months after the injury, a swelling appeared which has steadily increased in size since then. Throughout he has had morning vomiting which has never contained blood.

Examination.—The general examination was negative. The abdomen is markedly swollen in the epigastric region, where there is a large tender mass extending from the costal margin almost to the navel and laterally about five inches to each side of the median line. The mass seems elastic, semifluctuant and quite superficial. It is continuous with the liver dulness. A test meal was negative. The stools contained blood once. Hæmoglobin 72 per cent., leucocytes 8000, polymorphonuclear 74 per cent. The temperature ranged from 99° to 101° F.

The patient was then transferred to the surgical side (Dr. Hartley's Service).

Operation (December 16, 1908).—Median epigastric incision over the centre of the mass, exposing a large cystic mass projecting from the liver surface. On aspiration with a trochar 82 ounces fluid blood were obtained, the removal of which left a large cavity which extended deeply into the surface of the liver. This cavity was packed with two large one-yard gauze rolls. The other viscera felt normal. His convalescence was uneventful and he was discharged from the hospital at the end of six weeks. Four months after the operation he was reported as free from pain. His stools were normal and he had again resumed work.

This case presents many features of interest, viz., the long period of symptoms, the gradual appearance of the swelling, the marked alcoholic history (he was under observation and treatment throughout the period of the above illness for an obvious alcoholic gastritis), the size of the blood cyst, and the long period (five months) which elapsed between the injury and the operation.

TYPE II. TEAR OF BOTH CAPSULE AND PARENCHYMA

(*A*) *Cases with complete severance of a large portion of the liver.* (Two cases, two deaths; mortality 100 per cent.):

CASE III.—Joseph P., aged two and one-half years, admitted to Bellevue Hospital (Second Surgical (Cornell) Division) May 4, 1910, with a history of having been knocked down and trampled upon by a horse one-half hour before admission.

Examination.—Child in marked shock, extreme pallor of face and lips, skin covered by cold sweat. Complains of pain and thirst. Pulse not felt at the wrist, heart sounds weak. Right thigh is held flexed. Respiration is gasping in character, costal in type. Abdomen seems full and rigid. There is tenderness, especially over the whole right half. There is dulness which is movable in both flanks.

Operation (one-half hour after injury).—Intravenous saline infusion was begun and continued throughout the operation, patient receiving 36 ounces. Median epigastric incision. The belly was filled with blood. The liver was pale in color. There was a complete tear through the right lobe just external to the gall-bladder fissure completely separating the liver into two portions. The torn surface was not bleeding. The child's condition became so grave that the belly was closed just as the child died.

CASE IV.—Gertrude S., aged twenty-two, admitted to the New York Hospital, January 9, 1915, with a history of having been run over by a truck twenty minutes before admission. The patient was semiconscious and in great shock. Her face was pale, eyes sunken, lips cyanosed, extremities cold, and she was covered by a cold sweat. The pulse was not felt at the wrist and heart sounds were not audible. Temperature 98° F. The abdomen was flat and rigid in the upper half, especially on the right side where there was some tenderness. There was movable dulness in both flanks, but no change in liver dulness.

Operation (within an hour after injury).—The patient was given 800 c.c. saline solution intravenously. The feet were elevated and the extremities bandaged. After the above preliminaries the patient became conscious and a good pulse was obtained at the wrist. Examination at this time seemed to show that most of the fluid was in the left flank, although bimanual pressure over the liver caused the patient the most pain. Ether was the anæsthesia. A four-inch median incision was made. The belly was filled with blood. There was a large rent in the under surface of the right lobe of the liver which divided the liver in half except for a small portion of the capsule and the parenchyma over the anterior surface and dome of the liver just to the right of the falciform ligament. From this rent active hemorrhage was taking place. The rent in the liver was packed with gauze, which apparently controlled the hemorrhage. The wound was closed and the patient left the operating table in good condition. She gradually grew worse, however, and died twelve hours after injury.

(*B*) *Cases with varying degrees of liver lacerations:*

Case V.—Elias L., aged fourteen, was admitted to Bellevue Hospital (Second Surgical (Cornell) Division) in July, 1908, with a history of having fallen six stories from a roof, striking on his right side against a fire escape on the way down and landing on the right side. He was in extreme pallor and shock. His respiration was shallow and rapid and there was no radial pulse. Temperature 99° F. There were no signs of external injuries on the abdomen. The abdomen was flat and everywhere rigid, especially so in the right hypochondrium, where it seemed most tender. There was dulness in both flanks which was movable. The right thigh was flexed and the patient lay on his left side.

Operation (Begun One Hour after Admission).—A median incision was made. The belly was full of blood. There was a laceration three inches long and a half inch deep on the concave surface of the liver just mesial-wards from the gall bladder. There was no visible bleeding from the torn surface at operation. Gauze cigarette drain packing. Saline irrigation and the belly was closed full of salt solution. The foot of the bed was elevated, recovery was uneventful, and the patient was well six months after the operation.

Case VI.—Joseph M., Italian, aged forty-five, was admitted to the New York Hospital, August 26, 1909, with a history of having been struck in the upper abdomen by a heavy piece of lumber. Following the blow he had pain in the abdomen and felt weak and sick. He was brought to the hospital in shock. The pallor was marked, pulse not felt at the wrist. He was covered by a cold sweat, and respiration was gasping and costal in type. Examination showed no visible superficial contusion of the abdomen. The abdomen was retracted and hard as a board, with general abdominal tenderness most marked in the upper right quadrant. Bimanual pressure over the liver caused pain referred to the right scapular region. There was dulness in both flanks which was movable. The liver dulness was diminished. The temperature was 98° F., white cells 12,000 with no differential.

The operation took place three and a half hours after the injury through a median incision. The belly was full of blood. There was a laceration on the concave surface of the right lobe of the liver well down in the flank running from behind forward. There was a ragged wound admitting four fingers for about two inches. No oozing was visible. A large cigarette gauze drain was placed through the stab wound in the flank. Irrigation and removal of clots. The belly was closed full of saline solution. The foot of the bed was elevated; proctoclysis was given. The subsequent pain distention was marked. There was more on the third day. The recovery was uneventful. The drain was removed the eighth day. The patient remained eighteen days in the hospital. During that time his temperature was never above 100.5° F. The patient was well one year after the operation.

CASE VII.—William M., colored, aged twenty-six, was admitted to the New York Hospital suffering from severe pain over the right ribs and abdomen. His history was that he had fallen down twelve steps, striking on his right side against the edge of a chair. He was temporarily unconscious, but came later to the hospital in a cab. The patient showed signs of shock with marked pallor. He was covered with cold sweat, his pulse was small, rapid and easily compressible. Respiration was rapid, shallow, and costal in type. Examination of the abdomen showed it to be retracted with no respiratory movement. There were no signs of external injury. The abdomen was everywhere rigid. There was tenderness over the right hypochondrium. On bimanual pressure over the liver, the patient complained of pain over the eleventh rib behind and in the scapular region. There was liver dulness to the costal margin with movable dulness in the right flank. His temperature was 98.6° F. rectal, white cells 10,000, polymorphonuclear 77 per cent., blood-pressure 95.

Operation (One Hour after Injury).—Median incision. The belly was full of blood. There was a laceration of the free edge of the right lobe of the liver well down in the flank extending about three inches on the convex and three inches on the concave side at the level of the liver wound. Irrigation and removal of clots. Closure of anterior wound and belly full of salt. There was subsequent pain, with distention for two days, finally relieved by a movement of the bowels. The recovery was uneventful. The drain was removed on the seventh day. The patient remained in the hospital eighteen days. During that time his temperature ranged about 101° F., falling on the eighth day.

CASE VIII.—Louis R., aged ten, was admitted to the New York Hospital, October 13, 1914, suffering from epigastric pain and vomiting. His history was that on the day of admission, while pushing a stick along the slot of a trolley track, the stick slipped and he fell upon it with some force, striking his abdomen halfway between the xiphoid and the umbilicus in the midline. There was severe pain. He was breathless and unable to move for a few moments. He was able to go home and lie down. Soon after that he began to have severe pain just above the umbilicus and vomited. He was brought to the hospital. He did not seem acutely ill, but showed evidence of inconstant pain. His respiration was a little shallow and rapid. There was dulness in the upper right flank which was not movable. Upon examination the abdomen was flat, slightly retracted and the respiratory excursions diminished. The upper abdomen was rigid, the lower half fairly soft. The rigidity was most marked over the epigastrium. There was tenderness over the entire upper abdomen, maximum in midline, half way between xiphoid and umbilicus. White cells 24,000, polymorphonuclear 84 per cent.

The operation was exploratory laparotomy and repair of the liver, five hours after the injury. A high median incision was made. On opening the peritoneum there was fresh blood in the

upper abdomen apparently pocketed beneath the liver. Exploration of the stomach and duodenum was negative. On the under surface of the liver at the junction of the right and left lobes there was a stellate rupture, its longest tear one and a half inches. Hemorrhage was not active. The omentum was brought up and plugged into the laceration. This was fixed into position by suture to the posterior border of the falciform ligament. Tier closure of the abdomen. No drainage.

CASE IX.—Patrick McG., aged fifty-four, stableman, was admitted to the New York Hospital, June 17, 1915, with a history of having been kicked in the abdomen by a horse about two hours before admission. After the blow, which winded him, he felt well except for some pain in the upper abdomen, and started for home. After walking about four blocks he had sudden severe pain in his belly which doubled him up and made him feel sick. On admission to the hospital he was in extreme shock, covered with cold sweat, pale and quite restless. His respiration was shallow and costal in type. His pulse was rapid, small and of low tension. Temperature 98.6° F. On examination the abdomen was flat. There was no evidence of external injury. There was rigidity which was most marked in the right hypochondrium. General abdominal tenderness, especially over the right upper quadrant. Pain referred to the right scapular region on bimanual pressure over the liver. There was dulness in both flanks which was movable. No change in liver dulness. White cells 50,000, polymorphonuclear 89 per cent.

Operation (About Six Hours after Injury).—A four-inch right paramedian incision. The abdomen was filled with blood. On the anterior surface of the right lobe about four fingers from the free edge of the liver and equidistant from the falciform ligament were two irregular lacerations about two inches deep by three inches long, which were still oozing. The wound was packed with gauze. Tier closure of the abdomen. The patient's condition was critical throughout. Blood removed by Kenyon-Pool suction during operation. Patient was given proctoclysis and hypodermoclysis.

Twenty-four hours after the operation the patient's condition became satisfactory. Blood count: hæmoglobins 50 per cent.; red cells, 2,168,000; white cells, 15,500; polymorphonuclear, 96 per cent. The packing was removed the tenth day. The patient's condition remained satisfactory until July 4, seventeen days after the operation, when he evidently developed a pulmonary embolism with a rise in temperature to 101° F. This temperature continued for two weeks, ranging from 99.6° to 101.4°, when it became evident that the patient had a suppurating process somewhere. Aspiration of the chest in the subdiaphragmatic region gave negative findings. On July 26, thirty-nine days post-operation, there was an abscess in the liver region, and on July 28, the sinus was opened by Dr. Farr and an abscess between the liver and the

diaphragm opened and drained. Following this, the patient made a satisfactory recovery and reported well eleven months after the injury.

CASE X.—William S., laborer, aged twenty-four, was admitted to the New York Hospital, December 8, 1909, in the early evening. He was found unconscious by the ambulance surgeons, and had been caught between an elevator and the floor. The patient's chest was covered by petechial spots, the face was suffused, and there was a bilateral subconjunctival hemorrhage. The patient was unconscious upon admission, in extreme shock, with a small, rapid, slightly irregular pulse. The heart sounds were normal.

Upon examination there were found fractures of the seventh, eighth, and ninth ribs (right). Breath sounds distant, abdomen flat, no dulness in the flanks, and the house surgeon who saw him thought it a chest injury. He was given stimulants, etc., but never really regained consciousness. The next morning the patient was moribund when seen. The abdomen was distended, liver dulness decreased, and he died about sixteen hours after the injury.

Autopsy (Number 4534) (December 12, 1909).—By Dr. Elser: Body of a man 180 cm. long, large well formed frame, good musculature, good nutrition, skin over entire body very pale. On opening the abdomen about 300 c.c. partly fluid and partly clotted blood escaped mostly from the right side in the peritoneal cavity in front of the kidney. Liver normal in size, diffusely yellow in color, smooth surface, thin capsule. On the upper surface of the right lobe about 4 cm. to the right of the suspensory ligament there were three lacerations, the long axis of which corresponded to the long axis of the body. These were in line with one another separated by areas of well preserved liver tissue. The lacerations were about 2 cm. long, edges finely granular, and were covered with fluid blood. On section through the lacerations no hemorrhage extravasations into the liver tissue were visible. On section of the liver as a whole the substance was friable, yellowish-red in color, with the lobules well defined. Cause of death: Rupture of liver; hemorrhage.

TRANSPERITONEAL SIGMOIDOTOMY FOR THE REMOVAL OF TUMORS IN THE MUCOUS MEMBRANE*

By William J. Mayo, M.D.
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The large intestine and rectum are prone to the development of tumors of an adenomatous, papillomatous or fibrous character. Multiple adenomas, familiarly known as polypi of the rectum, multiple papillomas or intestinal warts, and an infectious type in which small mucoid growths develop as the result of an inflammatory process in the mucous membrane, form well-defined clinical groups. On exploration, the entire large intestine and rectum will often be found involved. A considerable percentage of persons suffering from these inveterate disorders eventually develop malignancy. When seen early, the malignancy is usually found confined to a single growth, but later a large number of the growths undergo malignant change, probably because of the seeding of small transplants from the original focus. However, I have observed patients who have had polyposis of the large intestine for years without the development of malignancy.

As to the cause of polyposis and allied conditions, there seems to be no well-defined knowledge, but there is an impression that the polypi are the results of transplants carried up and down the intestinal tract by normal and reverse peristalsis from a single primary growth. The mucoid growths have an infectious origin. Many patients become extremely cachectic as a result of the hemorrhages and exhausting discharges caused by these growths. For relief it occasionally becomes necessary to do a colectomy as far as the lower sigmoid. Later, by means of a snare, the cautery, fulguration or radium, the remaining growths are removed from the rectum and rectosigmoid. Soper has published an interesting report of a case of this description operated on by Bartlett.

In the frankly infectious cases which develop mucoid growths the infection will subside following an ileostomy (Brown) whereby the entire large intestine is put at rest for six months or more. Several patients have been cured in this way in our clinic, so that re-implantation of the ileum to the colon was not followed by a recurrence. Occasionally this method of treatment will prove efficacious and result in cure in polyposis. Therefore, before doing a colectomy, it is wise to do an ileostomy and wait some months to ascertain whether or not the polypi will disappear. In the meantime the rectum and lower sigmoid should be cleared of visible polypi, and the colectomy, if necessary, done as a secondary procedure. A complete ileostomy gives less annoyance than a colostomy; the stool soon becomes semisolid, is easily caught in a suitable container, and is nearly free from odor.

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Localized polyposis, usually limited to one or two polypi of a fibrous character, is often found in the ampulla of the rectum. Such tumors become more and more pedunculated until they may be extruded from the anus with the stool and require replacement after each evacuation. A favorite seat of single polypi and localized papillomatous growths is in the lower sigmoid and rectosigmoid. When pedunculated, they can be removed through the sigmoidoscope by the cold wire. However, in this situation they are less frequently pedunculated, and may be completely sessile. Patients with

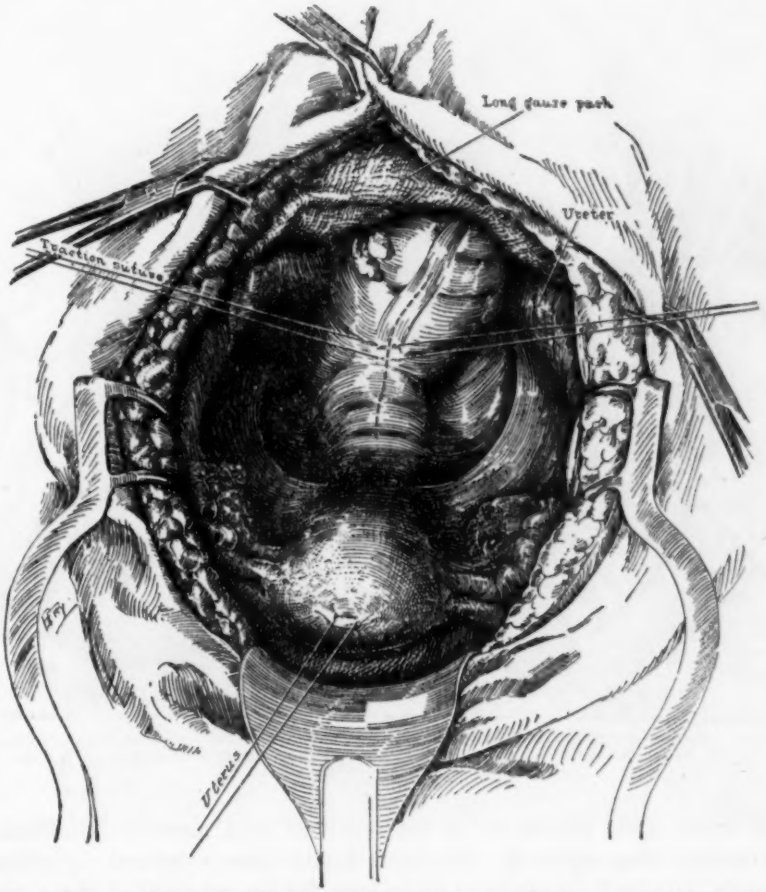

FIG. 1.—Exposure of lower sigmoid for removing tumor from within lumen. Dotted line shows proposed incision with traction sutures in place.

such growths have blood, mucus, and purulent discharges from the rectum and a sense of uneasiness and gas in the lower sigmoid, signs and symptoms which call for careful sigmoidoscopic examination.

The condition of the lower sigmoid and rectosigmoid is, in a way, somewhat similar to that of the ampulla of the rectum in its relation to the sphincter. The rectum proper begins at the middle of the third sacral vertebra and is derived from the cloaca, a highly differentiated part of the hind

gut. At the juncture of the sigmoid and rectum in most persons (Jonnesco) there is a marked change in the mucous membrane and a very considerable narrowing. Reeves, in a recent anatomical research on cadavers, found that this narrowing existed in 80 per cent. and amounted to a constriction in 5 per cent.

Attempts to remove sessile tumors located in the lower sigmoid, through the sigmoidoscope, are not unattended with danger, and perforation with

FIG. 3.—Clamps catching normal mucosa. Growth being burned off by cautery.

FIG. 4.—Continuous catgut suture placed around forceps, for closure of defect in mucosa. (Pilcher method.)

death from septic peritonitis as the result of such more or less blind procedures has been reported. We have found transperitoneal sigmoidotomy a simple, safe and satisfactory procedure for the removal of these tumors. A fragment from the growth, as exposed by the operation, can be removed for microscopic examination of the frozen section, so that operation can proceed more or less extensively as indicated. Such an examination is satisfactory provided a piece of tissue is secured which is representative of the structure of the growth. The tearing off of fragments from a growth for examination admits of the possibility of infection of the growth itself, which may result in invasion of the blood-vessels and lymphatics by cancer, if this disease be present, and lead to metastasis in the liver or glands.

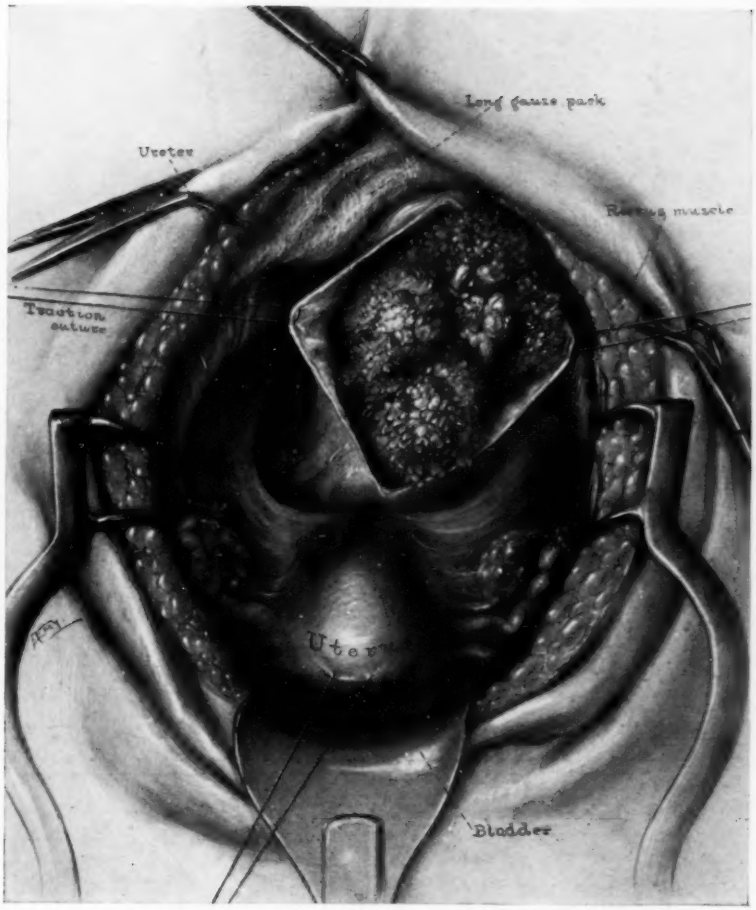

FIG. 2.—Papillomatous growth presenting through the opened sigmoid.

I always regret the necessity for excising a section from a doubtful growth unless the entire growth can be immediately removed if malignancy is established. Under any circumstances, the site from which the section was removed should be immediately sterilized with the cautery. It must be remembered, also, that unless the entire growth is given to the pathologist,

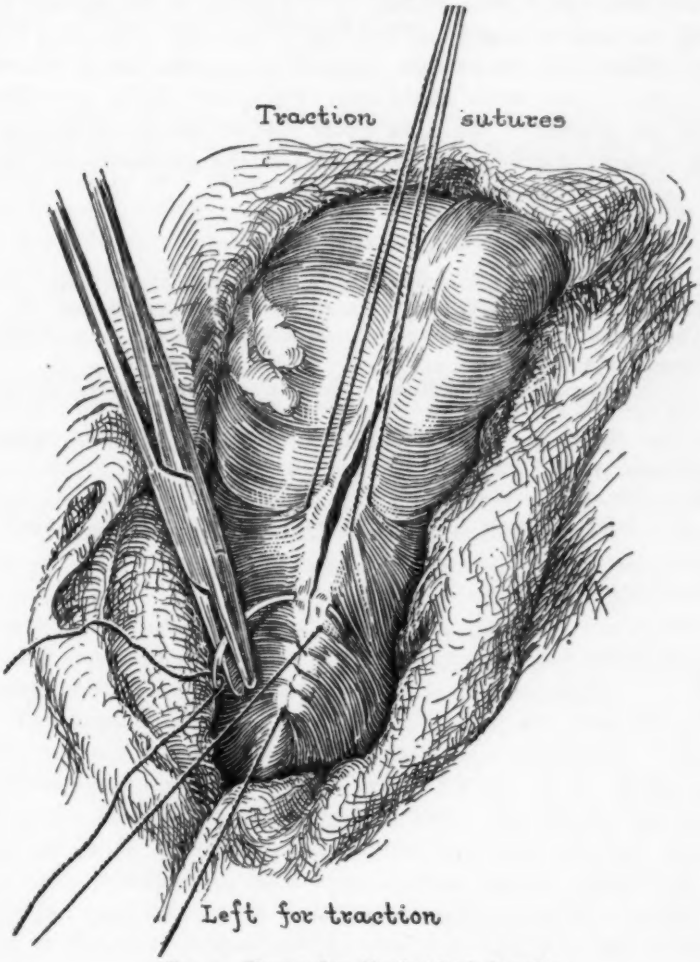

FIG. 5.—Closure of working incision in intestine.

a positive opinion is the only opinion of value; a negative opinion can be accepted only from an examination of the entire specimen.

The technic for removing such growths by transperitoneal sigmoidotomy is quite simple, and the illustrations which were made by Miss Fry from a recent case require little comment. The abdomen is opened in the midline, suprapubically, and a Balfour self-retaining speculum adjusted (Fig. 1). A moderate Trendelenburg with a pack gives good exposure. We now seldom use the exaggerated Trendelenburg, and in old and adipose persons we are especially cautious in this respect. The sigmoid is opened on the anterior

longitudinal band as nearly opposite the tumor as possible (Fig. 2), and the tumor is exposed, drawn through, and double clamped (Fig. 3). The growth is removed with the cautery and the defect closed from the mucous side by continuous sutures of chromic catgut after the method devised by Pilcher for the excision of hemorrhoids (Fig. 4), and covered on the peritoneal side with a few interrupted silk sutures. The incision in the sigmoid is then closed with continuous catgut and interrupted fine silk (Fig. 5). We then pass a red rubber tube up into the sigmoid beyond the line of sutures and fasten it with a catgut suture to the anus; this is left *in situ* for a few days to prevent gas pressure. We have never applied this procedure to frank malignant growths, but for growths similar to the papilloma shown in the drawings it will be found most efficient.

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THE VALUE OF THE X-RAY EXAMINATION IN CHOLELITHIASIS

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One may be very sure of a clinical diagnosis of gall-stones, but as a matter of fact, he cannot be *positive* that gall-stones are present unless he has seen them clearly in a röntgenogram. The statistics which I will present later on demonstrate that, at least in our work, we are able to show röntgenologically the shadows of gall-stones in approximately half of the positive cases.

Making the matter a personal one, I believe there are very few physicians with a clinical diagnosis of gall-stones who would consent to operation until after the Röntgen method had been tried if they realized that there was so favorable a prospect of gall-stone demonstration as one chance out of two. Of course, it is not to be understood for a moment that a negative Röntgen finding negatives the diagnosis, but a positive Röntgen examination clinches the diagnosis.

The demonstrability of gall-stones depends upon their composition. Gall-stones are composed mostly of cholestrin, a substance quite translucent to the X-ray. Gall-stones composed of pure cholesterin are practically invisible in the röntgenogram, but pure cholesterin stones are not so common as it was formerly supposed; for gall-stones nearly always contain some pigment, most likely calcium salts.

In a number of our cases, stones which had been removed at operation were subjected to an expert analytical examination. The stones were carefully weighed; the loss by drying at 100° C. carefully calculated, the crude ash finally estimated, and from this the percentage of calcium oxide in relation to the total weight of the gall-stones. In the cases where gall-stones were present yet not recognized by our Röntgen examination, the highest percentage of calcium oxide in relation to the total weight of the stone was 0.30 per cent., that is, the highest proportion of lime oxide in relation to the total weight of the stone in the invisible calculi was less than one-third of one per cent. Of the positive cases, a number of analyses were made of stones which cast shadows very difficult to recognize, seen only upon very careful oblique illumination of the röntgenogram. The lowest proportion of calcium oxide in relation to the total weight of the stone in these cases of faintly visible calculi was 0.425 per cent., or a little less than one-half of one per cent.

From the röntgenographic standpoint, therefore, cases of cholelithiasis fall under three heads:

1. Those where the gall-stones consist entirely, or almost entirely, of pure cholesterin, and are therefore invisible to the Röntgen ray, except in a few rare cases.

2. Those cases in which the large lime content of gall-stones renders it almost impossible to overlook them, even during the most careless examination. Such stones as these can easily be made out fluoroscopically.

3. Those cases in which the lime content of the stone is relatively low and the stone can be made out only by means of the most careful technic. It is in this third class that success or failure to secure as nearly as possible ideal röntgenograms marks the success or failure to a Röntgen diagnosis.

In a series of one thousand consecutive bismuth meal examinations reported before the American Medical Association in June, 1913, I found forty cases of gall-stones with eight additional cases not examined with the barium meal. Cole, in February, 1914, reported a series of twenty cases of gall-stones out of five hundred consecutive gastro-intestinal examinations, the same percentage as in my series. Pfahler, from a large experience, is convinced that gall-stones can be found in about 50 per cent. of the cases.

In autopsy statistics from nineteen American and European authors the average frequency of gall-stones is given as 5.9 in 18,892 necropsies. Hesse summarizes 17,402 autopsies done in ten years in Petrograd and found gall-stones in less than 3 per cent. The Johns Hopkins and Mayo clinics indicate that the figures are considerably below 10 per cent. Nevertheless, if we accept 10 per cent. as being a sufficiently generous estimate of the frequency of gall-stones in our gastro-intestinal and genito-urinary cases combined, we would expect to find one in every ten, or one hundred in every thousand of our patients to possess gall-stones. As a matter of fact, we have found positive Röntgen evidence in forty-eight out of a thousand, the same percentage found by Cole and Pfahler. This is one way in which we arrived at our estimate that in 50 per cent. of our cases gall-stones should be demonstrated röntgenologically.

In a series of more than five thousand consecutive patients examined for suspected disease of the gastro-intestinal tract, lumbar spine, or right kidney (these being the class of cases in which the gall-bladder region is automatically included) positive Röntgen findings were secured in 4.5 per cent. of the cases. Estimating that probably 10 per cent. of the patients had gall-stones, we, in this series, demonstrated 45 per cent. of them röntgenologically.

In all the above, of course, the figures are only estimated. Accordingly, we took a series of three hundred consecutive abdominal cases, operated by Drs. Kellogg, Harris and myself in the surgical wards of the Battle Creek Sanitarium, in which the surgical records show that the gall-bladder was examined at the time of operation and

in which pre-operative X-ray study had been made. Gall-stones were found at operation in forty-one cases, and of these, twenty had been reported "positive" in the pre-operative X-ray study, making the Röntgen diagnosis positive in between 45 and 50 per cent. of the cases. This, it seems, confirms the opinion that the Röntgen method is of considerable value in the search for gall-stones, although from 45 to 50 per cent. of the gall-stones are of such composition that they cannot be shown röntgenologically.

The X-ray is of further value in gall-bladder diseases, in many cases demonstrating right upper quadrant adhesions with fixation and even sometimes the thickened gall-bladder. In the series of three hundred cases just cited, there were fifty-five cases of gall-bladder disease, some without stones, in which the pre-operative X-ray report showed evidence pointing definitely to gall-bladder disease. These cases have all been tabulated in a paper published in the *American Journal of Röntgenology* for May, 1916.

We can therefore conclude that it is definitely possible to show gall-stones in approximately 50 per cent. of the positive cases and to show a gall-bladder lesion in 85 per cent. of cases of gall-bladder disease.

Of course, from the X-ray examination it is not possible to make a positive declaration as to the absence of gall-stones. Many patients are not operated. Percentages on this point would be extremely misleading. Hence, I have refrained from expressing my negative findings in percentages, except to show the absurdity of such statistics. The point I wish to make is that gall-stones are demonstrable with much greater frequency than has until lately been conceded. The frequency with which stones may be shown is so great that I believe the time has arrived when the X-ray examination should be required in every suspected case.

ACUTE PERFORATION OF GASTRIC AND DUODENAL ULCERS*

WITH A REPORT OF 36 CASES

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This paper comprises a study of 28 cases of acute perforation of duodenal and 8 cases of acute perforation of gastric ulcers admitted to the Episcopal Hospital since 1908. Through the kindness of Dr. H. C. Deaver and Dr. R. Neilson, I was permitted to operate upon eight of these cases. The stimulus that prompted me to study and report these cases was the wonderful immediate operative results of the cases reported by Dr. John B. Deaver of this city, and a careful study of cases operated upon and reported by Dr. Gibson of New York.

Perforation of a duodenal ulcer is the most frequent, serious upper abdominal catastrophe we are called upon to treat. Notwithstanding this or the fact that so much has been written within the past few years on their experimental production, diagnosis and operative treatment, very few of our cases were referred to the hospital with the correct diagnosis. In the majority of instances, however, a surgical diagnosis had been made.

Since 1908, 157 cases of duodenal and gastric ulcer have been treated in the Episcopal Hospital; as 36 of this number were admitted with acute perforations, the chance, according to these statistics, of a simple ulcer perforating is 22 per cent.

Innumerable pathologic conditions have been mentioned as possible causes of duodenal ulcer, and in many ways have they been produced experimentally. Durante, in an article entitled "The Trophic Element in the Origin of Gastric Ulcer," mentions no less than seventeen ways in which they have been produced experimentally. The great majority of duodenal ulcers occur in men, and almost every case of the perforated ones; in fact, in every case in this series, man is the one affected. This seems to occur with too great a regularity to be a coincident. Is there an anatomic, histologic or physiochemical difference in the alimentary tracts of the two sexes, or does the abdominal type of respiration in the male favor the production of, or, when once formed, the perforation of a duodenal ulcer? In perforations of typhoid ulcer the proportion is almost, though not quite, as great in favor of the male sex.

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* Read before the Philadelphia Academy of Surgery, March 5, 1917.

The diagnosis of a perforation of a duodenal ulcer is, as a rule, not difficult. The previous history of indigestion, the sudden, severe and excruciating pain in the epigastric region, sometimes followed by nausea and vomiting and the board-like rigidity of the upper abdominal muscles are usually present in every case. In a few of the cases, before the operation, we were unable to get a history of previous stomach trouble, but on closely questioning them after the operation we were able in all cases to elicit the fact that at times the stomach had given them some trouble.

It is surprising how infrequently patients suffering from an acute perforation of a duodenal ulcer exhibit symptoms of shock. Occasionally, however, it is a most serious factor. In one case of this series, a man sixty-two years of age who walked into the Receiving Ward, giving a history of a perforation a few hours previously, died an hour or two after admission from shock.

The absence of liver dulness is not regarded as a valuable sign. I am aware that its absence may be due to several causes, and also, for the sign to be of exact scientific importance, one should know the normal liver dulness of the patient in question. I believe, however, that it is of some value. In a case of acute hemorrhagic pancreatitis which I operated upon recently, with all the symptoms of an upper abdominal perforation, but having normal liver dulness, I made a diagnosis of probable duodenal perforation, but was not greatly surprised on opening the abdomen to find some other condition the cause.

To differentiate acute pancreatitis, perforation of the gall-bladder or that of a gastric ulcer from a perforation of the duodenum is often impossible. In some cases of appendicitis and in other inflammatory conditions within the abdomen that lead to a peritonitis, it may be impossible in the absence of a clear-cut history to make a correct diagnosis. Also in duodenal cases that have been perforated for several hours and have a diffuse peritonitis, unless you can obtain a clear history, it is only by the shrewdest guess that you are able to say other than that you are dealing with a perforative peritonitis. Besides the conditions mentioned above, the other causes we have encountered which atypically simulated an acute perforation of a duodenal ulcer were internal strangulated hernia, pneumonia, subdiaphragmatic pleurisy, visceral crises of tabes, gastritis, lead and ptomaine poisoning.

In the treatment of a perforation of a duodenal ulcer, all surgeons agree, with the exception of a few minor points in the technic, that the ulcer should be closed; whether or not a primary gastro-enterostomy should be performed is still a debatable question.

The best reasons advanced why a primary gastro-enterostomy should be performed are: To remedy any possible obstruction at

the pylorus resulting from encroachment upon the lumen of the duodenum, due to infolding of the ulcer; to obstructive œdema, that might follow shortly after operation; to late cicatrization; to place the duodenum and stomach at rest by dependent drainage and to bring about a cure by changing the chemistry of the stomach. Also, in cases of multiple ulcers, it acts as a cure and prevents complications incident to them.

The arguments against the performance of a primary gastro-enterostomy are: That it adds several minutes to the operation, it opens up the lesser peritoneal cavity to infection, and that a gastro-enterostomy does not always work the wonders it is supposed to, being very much like the little girl who " when she was good she was very, very good, but when she was bad she was horrid."

Primary gastro-enterostomy has nothing to do with the immediate results other than to forestall the possibility of pyloric stenosis. It, however, does render the patients more comfortable immediately following the operation, reducing the tendency to spit up or vomit. They are able to take substantial nourishment at an earlier date and thus hasten their convalescence.

Gibson, after a study of the end-results of fourteen cases, rejects primary gastro-enterostomy. He says, " I consider it unwise to do a gastro-enterostomy for a condition which is going to be cured anyhow." Case VII of my series is quite interesting and seems to bear this statement out.

> C. I., aged twenty-seven, diagnosis acute perforation of a duodenal ulcer, of six hours' duration. At operation a large chronic callous ulcer, nearly the size of a quarter, was found. This was closed by three layers of sutures. Cultures taken from the ulcer were negative, but from the upper and lower abdominal cavities diplococci were found. The patient, four weeks after the operation, developed a subdiaphragmatic abscess, for which he was operated by the transthoracic route with fatal result.
>
> *Post-mortem.*—Entire stomach and duodenum removed and showed nothing macroscopically, the duodenum appeared normal and there was no occlusion.

Our immediate results in cases where primary gastro-enterostomy was performed have been excellent and in those cases in which a gastro-enterostomy was not performed the mortality could in no way have been influenced by so doing, as these cases died of pneumonia, peritonitis and subdiaphragmatic abscess. Dr. John B. Deaver has had a most wonderful experience in acute perforations of duodenal ulcer and has operated upon 46 cases with but one death. In all but three of these cases he performed a primary gastro-enterostomy, truly a wonderful record and one that proves beyond doubt that the addition of a gastro-enterostomy does not increase

the mortality. Dr. Deaver's great skill and dexterity, however, make it possible for him to get results in a procedure of this kind far better than statistics usually show.

Our own experience in these cases with primary gastro-enterostomy has been excellent, having had ten without a death. I feel as if these cases were more or less picked ones, so hesitate to offer them, other than to show that primary gastro-enterostomy does not add to the mortality. Certainly two of the arguments against gastro-enterostomy, namely, the prolongation of the operation and the danger of spreading the infection, can be eliminated. If there is danger of immediate or late pyloric obstruction, or if there are other ulcers present, then certainly a primary gastro-enterostomy should be performed.

In gastric ulcers Balfour has suggested that the act of perforation has a curative feature, and on this basis has advised the use of the cautery on simple ulcers. The post-mortem findings in Case VII of my series certainly add weight to this suggestion.

In thirteen of our cases cultures were taken with the following results: In four a smear and culture both proved negative; in three, the smear showed pus cells, but a culture failed to show a growth; cultures in the remaining six showed diplococci in three, streptococci in one, diplococci and bacilli in one and bacilli in one.

In indurated ulcers where it is impossible to satisfactorily infold, I think it wise to place a small cigarette drain at this site. Regardless of laboratory results I believe it good practice to drain the pelvis, as one cannot tell at the time of the operation whether or not organisms are present in the soiled peritoneal cavity, and if they are, their number and degree of virulency. In early operations it is considered by some unnecessary to drain. I have been unable to convince myself of this, as in one case upon whom I operated four hours after the perforation, the culture showed diplococci. Drainage also permits the escape of the discharged gastric and duodenal contents which it was impossible to mop away at the time of the operation. Flushing of the abdominal cavity is, as a rule, not to be advised. It may, however, be necessary in early cases, where the peritoneal cavity has been flooded by a large quantity, and I may add, with large pieces of undigested food.

A study of the end-results has been gratifying but not convincing. I have seen twelve of the duodenal cases and two of the gastric ones who had had perforations. Seven of the duodenal cases had had an enterorrhaphy and a primary gastro-enterostomy performed and the remaining five an enterorrhaphy.

In questioning these cases (duodenal) most carefully, in only one, a case of simple enterorrhaphy, did I find a perfect cure. This patient had had absolutely no trouble with his stomach since the operation. In the other cases all had had some gastric disturbance. In the great majority of instances, however, it was due to specific

TABLE I

AUTHOR'S CASES OF ACUTE PERFORATION OF DUODENAL ULCERS

Name	Age	Sex	Duration	Hours Perforated	Operation	Result	Cause of death
J. H.	53	Male	1 year	6 hours	Enterorrhaphy	Recovered.	
H. S.	28	Male	2 years	4 hours	Gastro-enterostomy and enterorrhaphy	Recovered.	
J. M.	38	Male	6 weeks	20 hours	Gastro-enterostomy and enterorrhaphy	Recovered.	
J. C.	62	Male	5 years	13 hours	Enterorrhaphy	Recovered.	
S. S.	23	Male	1½ years	8½ hours	Gastro-enterostomy and enterorrhaphy	Recovered.	
W. B.	24	Male	6 months	9 hours	Gastro-enterostomy and enterorrhaphy	Recovered.	
C. I.	27	Male	8 months	6 hours	Enterorrhaphy	Death	Subdiaphragmatic abscess.
J. A.	49	Male	7 years	8 hours	Gastro-enterostomy and enterorrhaphy	Recovered.	

TABLE II

OTHER CASES OF ACUTE PERFORATION OF DUODENAL ULCER

Name	Age	Sex	Duration	Hours Perforated	Operation	Result	Cause of death
C. S.	44	Male	1 year	48 hours	Enterorrhaphy	Death	Peritonitis.
J. W.	35	Male	1 year	8 hours	Enterorrhaphy	Recovered.	
C. J.	35	Male	2 years	6 hours	Enterorrhaphy	Recovered.	
S. N.	40	Male	4 years	12 hours	Enterorrhaphy	Death	Peritonitis.
M. F.	24	Male	1 year	8 hours	Enterorrhaphy	Recovered.	
G. F.	27	Male	1 year	7 hours	Enterorrhaphy and gastro-enterostomy	Recovered.	
W. K.	52	Male	1 year	10 hours	Enterorrhaphy and gastro-enterostomy	Recovered.	
W. H.	29	Male	8 months	48 hours	Enterorrhaphy	Death	Peritonitis.
T. K.	26	Male	3 months	18 hours	Enterorrhaphy	Recovered.	
J. T.	35	Male	3 years	6 hours	Enterorrhaphy and gastro-enterostomy	Recovered.	
J. McC.	50	Male	8 months	27 hours	Enterorrhaphy	Death	Shock.
R. W.	45	Male	2 years	8 hours	Enterorrhaphy	Death	Pneumonia.
I. B.	22	Male	2 weeks	9 hours	Enterorrhaphy and gastro-enterostomy	Recovered.	
E. M.	38	Male	5 years	6 hours	Enterorrhaphy	Death	Pneumonia.
W. S.	35	Male	2 years	3 hours	Enterorrhaphy and gastro-enterostomy	Recovered.	

TABLE III

CASES OF ACUTE PERFORATION OF DUODENAL ULCER ADMITTED TO THE HOSPITAL IN A MORIBUND CONDITION AND NOT OPERATED UPON

Name	Age	Sex	Duration	Hours Perforated	Operation	Result	Cause of death
J. C.....	34	Male	.....	30 hours	.....	Death	Peritonitis.
S. McC.....	41	Male	.....	48 hours	.....	Death	Peritonitis.
A. S.....	62	Male	.....	5 hours	.....	Death	Shock.
P. H.....	35	Male	.....	36 hours	.....	Death	Peritonitis.
H. K.....	29	Male	.....	72 hours	.....	Death	Peritonitis.

TABLE IV

ACUTE PERFORATION OF GASTRIC ULCERS

Name	Age	Sex	Duration	Hours Perforated	Operation	Result	Cause of death
H. S.....	37	Male	4 years	12 hours	Gastrorrhaphy	Death	Peritonitis.
J. M.....	53	Male	1 year	6 hours	Gastrorrhaphy	Recovered.	
M. G.....	21	Male	9 months	4 hours	Gastrorrhaphy	Recovered.	
E. E.....	25	Male	2 weeks	8 hours	Gastrorrhaphy	Recovered.	
W. F.....	53	Male	3 weeks	72 hours	Gastrorrhaphy	Death.	Peritonitis.
W. D.....	27	Male	4 years	6 hours	Gastrorrhaphy	Recovered.	
W. K.....	35	Male	2 years	8 hours	Gastrorrhaphy	Recovered.	

NOTE.—In three of these cases the ulcer was situated very close to the pylorus.

TABLE V

ACUTE PERFORATION OF GASTRIC ULCERS NOT OPERATED, ADMITTED TO THE HOSPITAL IN A MORIBUND CONDITION

Name	Age	Sex	Duration	Hours Perforated	Operation	Result	Cause of death
S. C.....	25	Female	.....	48 hours	.....	Death	Peritonitis.

causes, such as eating indigestible food, alcoholism, tobacco, etc. Several, and it was almost equally divided between the two types of operation, said they had to be very careful what they ate, and in two cases sodium bicarbonate was required to relieve attacks of hyperacidity. I selected four cases, two of enterorrhaphy and two of enterorrhaphy and primary gastro-enterostomy, for laboratory study. Only one, a gastro-enterostomy case, showed a normal acidity. The other three were above normal. An X-ray study showed one case, a simple enterorrhaphy, with slight gastric retention.

The post-operative advice is most important. Their mouths should be put in order, many of them have bad teeth; and they should be instructed what to, and especially what not to eat. Hot liquids, tobacco and alcohol should be forbidden. These instructions were given to nearly all of the cases on their discharge from the hospital. I was surprised, however, in making a study of the end-results, to find that only one or two had heeded the advice consistently.

To really know the true end-results these patients should be placed on the proper diet and they should live up to the instructions. They should also be carefully studied, as other conditions might be the cause for persistent or periodic gastric symptoms.

On the whole, the end-results of the cases studied in this series were quite good. It was, however, impossible after questioning them to say, " This is a case of simple closure," or " this is one on whom a primary gastro-enterostomy was performed."

THE RELATION OF THE ILIOHYPOGASTRIC NERVE TO THE RADICAL CURE OF INGUINAL HERNIA *

AN EXPERIMENTAL STUDY OF THE PHYSIOLOGY OF THE NERVE

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At a meeting of the New York Surgical Society, held November 11, 1914, Dr. Charles N. Dowd[1] read a paper entitled "Preservation of the Iliohypogastric Nerve in Operation for Cure of Inguinal Hernia." This paper created an unusual amount of interest. Obviously, the necessity of preservation of any normal anatomical structure is so evident, that the plea which Dowd makes seems almost unnecessary. However, in the discussion of this paper, a divergence of views arose as to the reasons for preserving the nerve. Most of the members of the Society advocated the preservation of the nerve, because there did not appear any reason why it should be destroyed. A few members, notably Taylor, Vosburgh, Woolsey, and Moschcowitz, expressed their belief that that part of the iliohypogastric nerve exposed in the operation for the radical cure of inguinal hernia was purely sensory, and that its injury, more particularly its inclusion in the suture line, was occasionally followed by an annoying neuralgia.

Dowd[2] was evidently not convinced by the opinion of those who dissented from him, because less than a month later, namely at the December 9, 1914, meeting of the New York Surgical Society, he offered additional evidence to maintain his contention. In discussing the new evidence, I stated that the results of a few experiments I carried out did not agree wholly with the results of similar experiments in Dowd's hands. In order to convince myself of the soundness of my views, I have instituted a complete reinvestigation of this matter.

In preface I shall say that the attempt at solution of our problem was not as simple as it appeared to be at first blush. Indeed, I soon learned that the problem was so involved that it was impossible for me to carry it out without assistance. I therefore desire to express my

* Read before the New York Surgical Society, February 14, 1917.

[1] Dowd: Annals of Surgery, vol. lxi, p. 204.

[2] Dowd: Annals of Surgery, vol. lxi, p. 483.

cordial appreciation of the service of my collaborator, Dr. Harold Neuhof, who carried out all of the animal experiments, and to other members of the Surgical Laboratory of the College of Physicians and Surgeons, notably Dr. Clark and Dr. Cunningham.

The subject may be discussed from two viewpoints, namely: (1) anatomy; (2) physiology.

(1) ANATOMY

A little reflection will very quickly show that the crux of the matter centres around the question as to whether that part of the iliohypogastric nerve which is ordinarily exposed in any one of the conventional operations for the radical cure of inguinal hernia is sensory, or motor, or mixed. Anatomists, however, are very obscure upon this point; most of them give but a very meagre description of the nerve, and not a single text-book is clear about the function of that part of the nerve which is under discussion. Finally, it must be also added, that the variations of the nerve, or, better said, the relationship between the iliohypogastric nerve and its two neighbors, namely, the twelfth intercostal and the ilioinguinal, are admittedly too numerous to admit generalizing deductions.

The consensus of opinion amongst anatomists appears to be that the iliohypogastric nerve is composed of nerve fibres which arise from the twelfth dorsal and first lumbar segments of the cord, and that frequently it arises in common with the ilioinguinal nerve. After emerging from the psoas muscle the nerve runs downward and forward in front of the quadratus lumborum, until it reaches the posterior aponeurosis of the transversus abdominis, and perforates the latter above the crest of the ilium. It then runs forward between the transversus abdominis and the internal oblique muscle, more or less parallel with its inferior fibres, and at a varying distance above the inferior edge of this muscle, until it reaches the linea semilunaris.

Most anatomists state that in the "posterior" part of its course, the iliohypogastric nerve gives off muscular branches to the transversus abdominis, and to the internal and external oblique; most anatomists are also agreed upon the fact that above the middle of the crest of the ilium, the nerve gives off a lateral cutaneous branch, which pierces the external oblique muscle, and descending over the crest of the ilium, is distributed to the integument over the gluteal region. After the main trunk of the nerve has reached the semilunar line, that is, slightly above the external inguinal ring, it pierces the aponeurosis of the external oblique, and is distributed to the integument covering the hypogastric region.

It is also conceded, that while the distribution of the iliohypogastric nerve as above outlined seems to be perhaps the one most frequently en-

countered, there are also numerous exceptions. The one most frequently met with bears a relation to the distribution of the ilioinguinal nerve; there appears to be a compensatory relationship between the two nerves, *i.e.*, in some cases the terminal portion of the iliohypogastric nerve is small, and then the ilioinguinal nerve is large, and *vice versa*. There are also frequently found communicating branches between the two.

The description of the iliohypogastric nerve, as I have just given it, is, so to speak, a composite picture of the nerve, derived from my own studies and consultations with the best authorities. So much is conceded by Dowd. Thus far, therefore, we meet upon common ground.

As a matter of fact the only difference of opinion centres around the question as to whether the iliohypogastric nerve sends any important nerve supply into the internal oblique within the zone of our operation. Most anatomists are agreed upon the point that the nerve in the posterior part of its course sends motor fibres into the lower part of this muscle. Dowd also infers as much when he makes the statement that "fibres are given off from these nerves as they course *through* (italics mine) the muscle. These fibres can be seen if careful dissection is made." Our operative field, however, is at a considerable distance from the point where the nerve pierces the muscles; and in our operative field the nerve merely lies on top of the internal oblique muscle, covered by a delicate fascia.

One further statement of Dowd regarding the more minute anatomy of the nerve requires at least a passing comment. It is the following: "Serial microscopic sections have also been made and they show the small fibres of the nerve between the muscle bundles and the main trunk." It appears to me that this statement is somewhat ambiguous, and for the following reasons: First, that to be of some value as an argument, that these are motor nerves, these histological data are altogether inconclusive; on the contrary it would be necessary to show by serial sections that these nerves are directly traceable into the main trunk; second, because no proof is brought forward, nor for that matter can be brought forward, as to whether these nerve fibres are motor or sensory.

(2) PHYSIOLOGY

To the uninitiated it doubtlessly appears that the establishment of the fact as to whether a given nerve is sensory or motor is a very simple matter. All that appears to be necessary would be to apply a faradic current; if the muscle attached to the nerve contracts, it is a motor nerve; if it does not contract, it is a sensory nerve. As a matter of fact, this is one of the proofs brought forward by Dowd, in order to prove his contention, and I confess, that for awhile I was under a similar impression I determined, nevertheless, to test this matter for myself. I therefore made the following experiments in a

number of consecutive cases. Well towards the outer part of the operative field the iliohypogastric nerve was carefully dissected free from the underlying internal oblique muscle, for a distance of one to two centimetres, and a piece of sterilized rubber tissue drawn underneath it. The function of the nerve was then tested, first with a mild, then with a medium, and finally with a strong faradic current, by means of a specially constructed sterilizable electrode. In my first two cases no contraction whatsoever was obtained; whereupon I hastily jumped to the conclusion that the experiment was an absolute proof of my contention, that the iliohypogastric nerve was a sensory nerve. In the next case, however, I did obtain contractions, and subsequently the results were either positive or negative without apparent reason.

In the next series of experiments I exposed and liberated the nerve in a similar manner, and then deliberately divided it; both ends were then stimulated in the same manner with a faradic current of varying intensity. Again my results were indecisive. Finally I reached the conclusion, that the results depended mostly upon the moisture within or upon the surface of the nerve, and that the current was conducted upon the moisture. Even this had to be tested out, and I did so by sending a faradic current into the muscle on a piece of dry and a wet silk thread. I found that contractions were obtained only when the latter was used. I have related these experiments not to prove my preconceived notions or to disprove the contentions of Dowd, but merely to show that these and similar experiments are absolutely unconvincing.

I next determined to test the matter out by deliberate division of the nerve in an actual operation, in order to determine the end results. All these cases were followed out long enough to enable me to state definitely that no harm resulted therefrom, and that a perfect end-result is maintained. This experiment may also serve to answer the contention, that very important trophic nerve fibres are given off from the iliohypogastric nerve to the internal oblique. Incidentally I may mention that the entire subject of the importance of trophic nerve fibres to muscles is so involved that only speculative views are current.

To recapitulate, the component elements of the entire problem are the following:

1. It is conceded that at its origin the iliohypogastric nerve is a mixed nerve.

2. It is conceded that its termination in the skin is purely sensory.

3. It is conceded that in its posterior part it supplies motor filaments to the internal oblique and transversalis muscles.

4. Granting these three propositions, it follows also that in some part of its course the iliohypogastric nerve ceases to be a mixed nerve and becomes purely sensory. The question, therefore, is where is that

point, and, more particularly, is that point proximal or distal to its exposure in our operation for inguinal hernia?

I have already pointed out the fallacies of the methods hitherto pursued, especially in my hands. Therefore, after consulting with Prof. Lee, of the Department of Physiology, and with Prof. Tilney, of the Department of Neurology, of the College of Physicians and Surgeons, the conclusion was reached, that the only way to prove or disprove my contention, was by a rather complicated animal experiment.

A little reflection will show that the only way to prove the problem experimentally was to cause a degenerative process in the peripheral distribution of the nerve; and the simplest method by which to attain such a degeneration is by a section of the nerve.

Further reflection will also show that in order to be of value the nerve section must be made in such a manner that either the sensory or the motor part of the nerve will degenerate, but always to the complete exclusion of the other. A study of Fig. 1, illustrating diagrammatically a peripheral nerve with the corresponding segment of the spinal cord, shows that a section of the nerve can be made at three different points.

1. A section made at 1 will be of no value, for the reason that the entire nerve distal to the section, namely, both motor and sensory, will degenerate, because both portions have been separated from their centres, which for the sensory fibres is in the gamglion upon the sensory root, and for the motor fibres in the gray matter of the anterior horn of the spinal cord. It is evident, therefore, that our section must be made upon a part of the nerve before its sensory and motor portions have become united.

2. Similarly it would be absolutely of no value to divide the posterior nerve roots at 2 (Fig. 1) (a comparatively easy operation); because after such a section none of the peripheral nerve would degenerate, for the reason that neither the motor nor the sensory part of the nerve has been separated from its centres.

3. There remains, therefore, only the third possibility, namely, to make a section of the anterior nerve roots at their emergence from the anterior horns; as is indicated at 3 of Fig. 1.

The rationale of the operation is the following:

(*a*) Such a section would cause a degeneration of all the peripheral part of the motor nerve, because it has been separated from its centre in the gray matter of the anterior horn of the spinal cord.

(*b*) Such a section would cause no degeneration in the peripheral sensory part of the nerve, because that part of the nerve is still in connection with its centre in the gamglion upon its root.

(So delicate is this test that even an accidental injury of the posterior nerve root in the course of the operation would have no deleterious effect upon the experiment; all that such an injury could do would be to cause a degeneration of the corresponding nerve fibres in the spinal cord.)

(*c*) Assuming now that the animal survived the operation for a period of time sufficiently long to have caused a degeneration of the nerve, it will be necessary to examine different portions of the nerve for degenerative changes. From the nature of the experiment it also follows, that all that portion of the nerve which is degenerated must be motor; and whatever is not degenerated must be sensory.

(*d*) In order to prove our contention beyond any doubt, it is absolutely important that every one of the anterior roots which enter into the formation of the iliohypogastric nerve be divided; because it is also perfectly possible that some motor fibres might have escaped degeneration in the peripheral part of the nerve, and so might be mistaken for sensory nerve fibres. Even in the human being the forma-

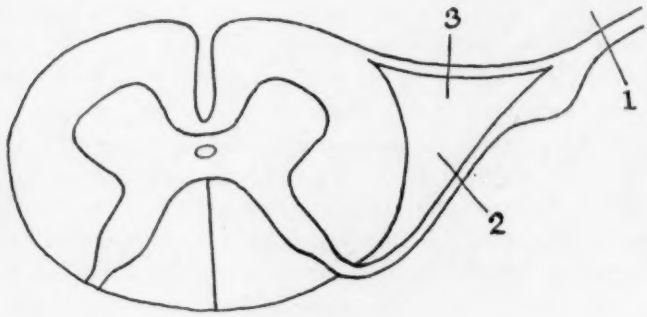

FIG. 1.

tion of the lumbar plexus is not absolutely uniform; as already stated, however, the consensus of opinion is, that the iliohypogastric nerve is a branch of the first lumbar nerve, and receives also fibres from the last intercostal, so that all that would be necessary in the human being would be to divide these two roots. In the dog, however, there appear to be so many variations, that to be absolutely certain one would also have to divide at least the two adjoining nerve roots, namely the eleventh dorsal and second lumbar; and to be absolutely certain it was decided to divide at least five roots. This, of course, increases the risk of the operation and also the dangers of infection; and it is particularly on this account that our absolutely successful experiments are limited to two.

Five experiments were performed. The results, as already stated, were satisfactory in only two. It was found that a very long exposure of the cord was required to divide five roots in the region in question, and that one was not always successful in the division of the anterior roots. So much of the bony support of the spinal column was necessarily removed, that some bowing of the back was unavoidable. The

operation partakes necessarily of a very major character. These remarks will serve as an explanation for the three unsatisfactory results. One dog died two days after operation. In another there was a wide separation of the wound, exposure of cord, and incomplete division of the nerve roots. In a third case the roots were incorrectly selected and incompletely divided. It should be clearly understood, however, that in none of these unsatisfactory experiments did examination of the iliohypogastric nerve in the inguinal region show any trace of degeneration. It should be also stated, that in our opinion, a single satisfactory experiment in degeneration after root section is sufficient to establish the point in question, when as many as five roots (two above and two below the main, if not the entire source of the iliohypogastric nerve) are divided.

The successful experiments are the following:

Experiment 1.—Dog 88, good sized male. Operation, January 5, 1916. Dog in prone posture. Median incision over the lower dorsal and upper lumbar spine. Spinous processes of the eleventh and twelfth thoracic, first, second, and third lumbar vertebræ isolated by incising and stripping back the musculature on both sides. These spines and their laminæ were removed beyond the articular junctions. A long and wide exposure of the dura was thereby obtained. Tension sutures were placed through the dura, and the latter incised between them. Dura slit up and down with a grooved director. Some cerebrospinal fluid escaped. It was planned to divide the left anterior roots; therefore the left dentate ligaments were divided in order to mobilize the cord. The anterior roots were now divided by slipping a fine scissors under the posterior roots. Each division was followed by muscular contraction and rather free bleeding. The roots divided were the eleventh and twelfth dorsal, first, second and third lumbar. As the dura could not be sutured without constricting the cord, a strip of aponeurosis from over the erector spinæ, 2 cm. wide and of appropriate length, was sutured into the dural gap with fine silk. Layer suture of the muscles, aponeurosis of the erector spinæ and skin. Cotton collodion dressing.

Post-operative Course.—Primary union. For several days both hind legs were weak and dragged on walking. Reflexes were normal, however, and bladder and rectal control appeared undisturbed. Normal power in legs returned about eight days after operation. Animal sacrificed with chloroform, January 24, nineteen days after operation.

Post-mortem Examination.—Firm union of tissues. No evidence of infection. The cord is overspread by a dense layer of connective tissue, loosely attached to it. The dura is adherent to this layer only at the cut margins. Cerebrospinal fluid not encountered in the field of operation. No evidence of injury to the cord. The roots divided were again verified to be the eleventh and twelfth dorsal, the first, second, and third lumbar. The eleventh dorsal and second lumbar divisions did not completely separate the ensheathing connective tissue.

The iliohypogastric nerve was exposed throughout its entire course. (Right here we wish to mention, that in numerous dissections we have found that the peripheral course and distribution of the iliohypogastric nerve in the dog is exactly the same as in the human being.) No gross changes were seen. Sections were taken from various parts of the nerve and labeled: (*A*) From the upper

part of its course; (*B*) from the middle part of its course; (*C*) from that part of its course which lies in the inguinal region.

Microscopic Examination.—Surgical Pathology No. 3791. *A*, *B*, and *C*. Marchi's stain. Many slides made from each section, cut longitudinally.

Section *A* (Fig. 2) shows moderate amount of segmentation of the fibres and granular deposition of fat in approximately one-half of the longitudinally sectioned nerve. The other half shows no trace of degeneration.

Section *B* (Fig. 3) shows the same picture as *A*, with degeneration to the same extent and limitation.

Section *C* (Fig. 4) shows absolutely no trace of degeneration; normally staining nerve.

Experiment 2.—Dog 78, female, fair size. Operation, December 22, 1915, same procedure as in previous experiment. There was considerable oozing from the divided musculature, controlled by pressure. The posterior spinal vein was slightly injured in opening the dura, but a ligature was not required. The left anterior eleventh and twelfth dorsal and first, second, and third lumbar roots were divided. (The corrected root division is given in the post-mortem examination.) The dura was not sutured, and fascia was not implanted into the defect. Layer suture of the wound.

Post-operative Course.—Slight separation and infection of the upper part of the wound. No evidence of cord injury. Animal sacrificed with chloroform on January 7, 1916, sixteen days after operation.

Post-mortem Examination.—Thin inflammatory membrane over the upper part of the cord exposed at operation.

The left anterior roots were found completely divided. They were the tenth, eleventh, and twelfth dorsal, and first and second lumbar. No gross changes were seen in the left iliohypogastric nerve.

Sections were taken as in the previous experiment and similarly labeled *A*, *B* and *C*.

Microscopic Examination.—Surgical Pathology No. 3813, *A*, *B*, and *C*. Marchi's stain. Sections cut longitudinally.

Section *A* (Fig. 5): In different slides moderate to severe segmentation and fragmentation of the nerve fibres into thick zones, with a mass of non-degenerated fibres in the middle. The total diameter of the degenerated portion approximately equalled that of the non-degenerated mass of nerve bundles.

Section *B* (Fig. 6): Approximately one-half of the nerve shows moderately advanced degeneration.

Section *C* (Fig. 7): No evidence of degeneration; normally staining nerve.

These two successful experiments therefore prove the following:

1. The posterior part of the iliohypogastric nerve is a mixed nerve, *i.e.*, both motor and sensory.

2. That part of the iliohypogastric nerve which is exposed in the conventional operation for the radical cure of inguinal hernia is purely sensory.

RÉSUMÉ

1. That part of the iljohypogastric nerve which is exposed in the conventional hernia operation is to be preserved, because there is no necessity for dividing it, and also because its complete division will be followed by a temporary anæsthesia of the hypogastric region. After

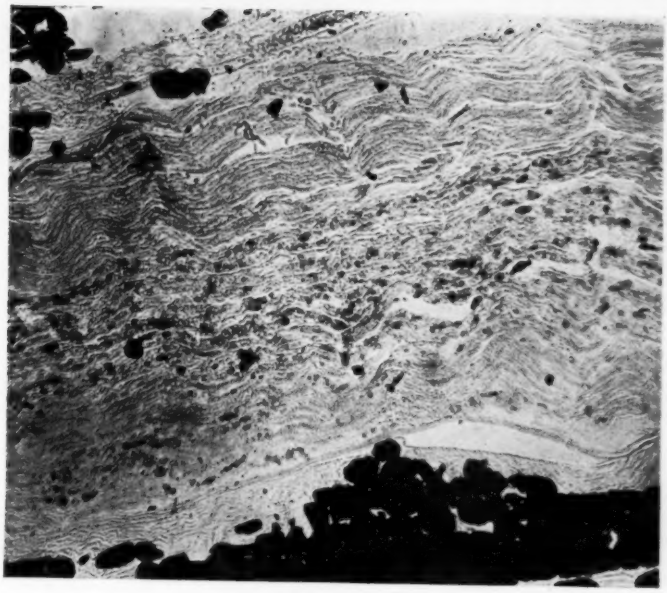

FIG. 2.

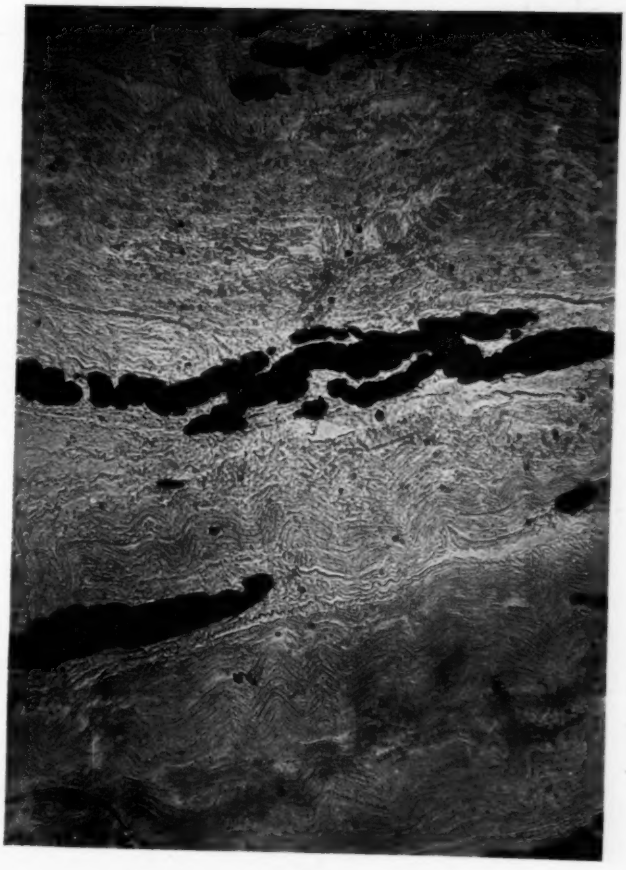

FIG. 3.

FIG. 4.

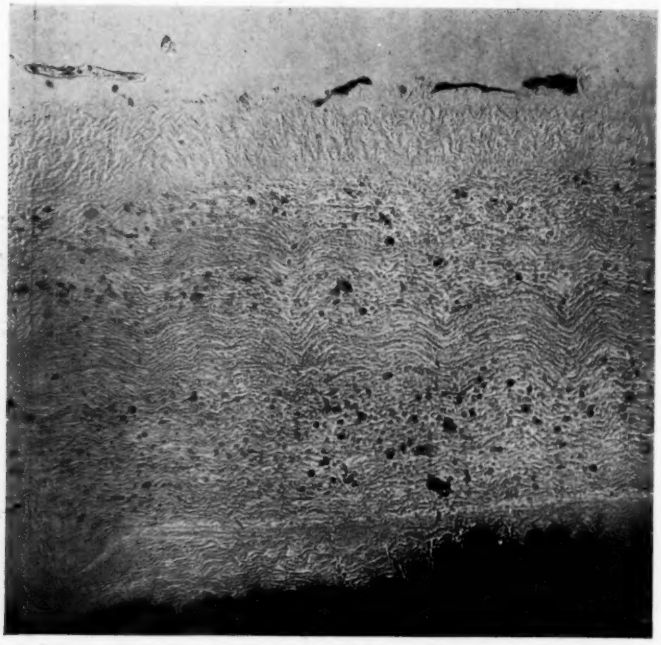

FIG. 5.

FIG. 6.

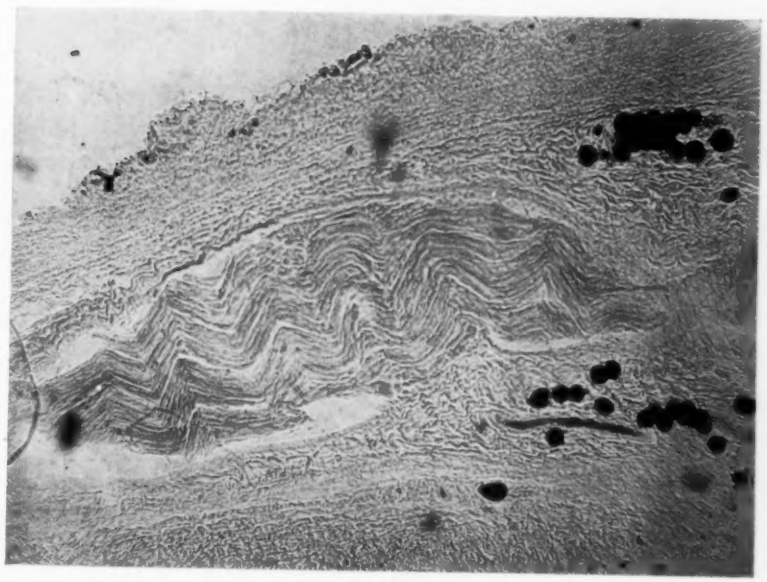

FIG. 7.

a while regeneration of the nerve occurs and the anæsthesia disappears.

2. The nerve should be protected from a careless inclusion in the suture line. Such a careless inclusion is likely to be followed by a neuralgic pain.

3. A careless division of the nerve is not followed by a local paralysis of the internal oblique muscle and therefore has no bearing upon the radical cure.

SOME OF THE PROBLEMS OF PLASTIC SURGERY *

By John Staige Davis, M.D.

of Baltimore, Md.

By plastic and reconstructive surgery I mean that branch of surgery which deals with the repair of defects and malformations, either congenital or acquired, and with the restoration of function and improvement of appearance. This is accomplished chiefly by the transfer of tissue, either from the immediate neighborhood or from some distant part. The deformities dealt with in plastic surgery for the most part involve the skin or adjacent soft parts, rather than the bones and joints, the ligaments or tendons. The treatment of large denuded surfaces, requiring skin grafting, and of intractable wounds, should also come under the care of the plastic surgeon.

In reconstructive surgery on the jaws and palate the plastic surgeon should have the coöperation of a skilled dental surgeon. The plastic surgeon, with his special knowledge of tissue transplantation, can be of great use to the general surgeon and to the orthopedist in repairing the defects left by certain necessarily mutilating operations. This also applies to the gynæcologist and genito-urinary surgeon, when called on to perform more extensive transplantations than they are accustomed to undertake.

My experience has been that we seldom, if ever, find two plastic cases exactly alike, and thus no "cut and dried" methods can be employed. Each case should be carefully studied and the various methods of repair considered from every standpoint. This endless variety in itself brings a certain fascination to the operative treatment, and to the after-care of these patients. Keen surgical judgment is often necessary to determine what should be done; whether or not a plastic procedure should be finished at one operation; how far to go in the initial operation, and when to follow with the secondary procedures. The results in certain groups of cases are very slow, and in these the process is one of gradual building up. In such cases the entire series of operations should be planned with regard to the ultimate result, and not to the immediate relief of the condition. The post-operative treatment and dressings should be done by the surgeon himself, or directly under his eye, as successful results in a great measure depend on skilful and judicious after-treatment.

The simpler the operation the more likely it is to succeed, and this is especially exemplified in the operations for the relief of

* Read before the Philadelphia Academy of Surgery, March 5, 1917.

harelip. It is wise to make haste slowly in plastic surgery, and to underdo, rather than overdo. Thorough familiarity with the free transplantation of skin, fat, fascia, bone and cartilage is essential, as all of these tissues are constantly utilized in reconstructive work. The principles of tissue shifting, and of the use of pedunculated flaps, must be understood, and also the possibilities of combinations with the above mentioned free transplants.

A few words concerning these transplantations may be of interest.

Transplantation of Skin.—The use of skin grafts is absolutely essential in plastic surgery. There is seldom a case of any magnitude in reconstructive work in which some form of skin grafting is not used at one time or another during the process.

Skin grafts may be divided in general into *thin grafts* where only the superficial layers are utilized, as obtained by the methods of Reverdin and of Ollier-Thiersch; and *thick grafts* where the whole thickness or nearly the whole thickness of the skin is used. This latter division includes *small deep grafts,* secured in much the same manner as Reverdin grafts, but often including the whole thickness of the skin; also the so-called Wolfe-Krause grafts, which include the full thickness of the skin.

Grafts may be further classified into auto-grafts, where the graft is obtained from the same individual; *iso-grafts* where the graft is obtained from another individual of the same species, and *zöo-grafts* where the graft is obtained from a lower species.

I will not go into the technic of obtaining these grafts, but will only say that both thin and thick grafts may be successfully transplanted on healthy granulating surfaces, as well as on fresh wounds.

Iso-Grafts.—There is much difference of opinion as to the advisability of utilizing iso-grafts, and many surgeons insist that only auto-grafts should be used. Of course, auto-grafts are more likely to succeed, but I feel convinced, when it is not possible to utilize auto-grafts, that iso-grafts are well worth trying, and that very good lasting results may be secured if the grafts are obtained and transplanted with the proper technic. The success or failure of iso-grafts may be dependent on the similarity of blood groups of the host and donor, and a subsequent report will be made on this point.

Zöo-Grafts.—Many successes have been reported following the use of zöo-grafts from various animals. My own experience is that these grafts take readily and receive their blood supply as promptly as ordinary grafts. They also have the power of stimulating wound as do other grafts. However, in every case which has been under my observation these grafts, after doing well and often when the wound is entirely healed, will suddenly with no apparent cause begin to melt away, and will soon disappear.

Transplantation of Fat.—Free fat grafts are used principally for filling in depressions. They can be successfully transplanted and enough of the tissue will survive to accomplish the desired purpose. Some surgeons prefer small bits and others pieces of considerable size and thickness. This tissue must be most carefully handled to prevent bruising. The defect into which it is placed must be perfectly dry and asepsis must be maintained. Fat is also used in plastic surgery to prevent adhesions around tendons and nerves. Often a pedunculated flap of skin with a very large mass of fat is transplanted, and in this way better circulation is assured.

Subcutaneous fat is the usual source of supply, and this is ordinarily abundant on the abdominal wall, or on the thigh. Omental fat has been used successfully, but one would hardly feel justified in opening the abdomen for the sole purpose of obtaining fat.

Transplantation of Fascia.—Fascia is used in plastic surgery for a number of purposes. It is valuable for reinforcing weakened or defective tissues. New tendons may be constructed of it. It may be used for the relief of ptosis. It may be used either alone or with fat in joints. Fascia lata is the favorite source of supply, but the deep fascia obtained almost anywhere is very satisfactory.

Transplantation of Bone and Cartilage.—Bone and cartilage are normally the supporting framework for the soft parts, and both are used for this purpose in reconstructive surgery. When bone is chosen for the supporting substance, it is advisable to leave the periosteum intact. It must be borne in mind that free grafts of bone, either with or without periosteum, when transplanted into soft parts will eventually absorb. I have found experimentally and clinically that a bone graft in contact with bone at one end and extending into the soft parts, without special function, will become thin and eventually lose its power to act as a support. However, if the bone transplant is placed in contact with living bone at each end, it will become a permanent supporting framework. Whether the graft lives or whether it is replaced is still a matter of dispute, the pros and cons of which we will not consider here.

Cartilage, on the other hand, is an ideal supporting substance for transplantation, and will live and not shrink when transplanted free, either with or without its perichondrium, into soft parts. It will also live when in contact with bone at one or both ends. Rib cartilage is the usual source of supply. Cartilage is flexible and thus less liable to subsequent fracture; it can be easily cut and shaped into any desired form; it is no more difficult to obtain than bone, and a large supply is always available. Any one of these advantages, it seems to me, would suggest the use of cartilage rather than of bone for the supporting material in transplantation for the correction of saddle nose, the filling out of sunken areas on the face, and also for the framework in rhinoplastic operations.

Mucous Membrane Transplantation.—Free grafts of mucous membrane are of little value either when transplanted to the eyelids or into the mouth. Mucous membrane offers little if any advantage in these situations over very thin Thiersch grafts, and the results are usually unsatisfactory. Pedunculated flaps of mucous membrane in the mouth are often successful, and if mucous membrane is not available, pedunculated skin flaps can be used with equal success, and with very good permanent results.

Subcutaneous Hydrocarbon Prosthesis.—The injection of paraffin has been advocated by a number of men, and is principally used for correcting certain deformities about the face. This can be done with a little practice by anyone who is able to purchase the equipment, and gives immediate results which are, at first, very satisfactory to the patient. This method is the sheet-anchor of the " quack " facial specialist. However, paraffin often shifts its position gradually, and trickles down the tissue planes, or, perhaps, the infiltrated tissues may thicken and cause deformities which are much worse than the original defect. For a number of years I have felt that the injection of paraffin, and similar substances, is bad surgery, and have spent much time in trying to remove the paraffin injected by others, and in correcting the deformities caused by these injections.

Definition of Terms.—By a *flap* we mean a mass of tissue attached at some portion of its circumference by a pedicle, which can be shifted at once or later as far as the pedicle will allow.

By a *graft* we mean a mass of tissue which is cut free to be transplanted wherever necessary.

A surface defect may be closed in one of four ways:

First, by skin grafting.

Second, by sliding the edges together and suturing, called the French method. In those instances where there is tension the skin may be mobilized to a very great extent by undercutting, and in this way large areas of skin may be shifted in without impairing its vitality. If direct union is impossible in a wound, even after undercutting, then lateral liberating incisions may be made, either on one or both sides, and the edges closed, leaving one or two smaller defects in place of a large one.

Third, by pedunculated flaps from tissue in the immediate neighborhood, called the Indian method. In some instances healthy flaps from adjacent tissue are impossible to get, especially in finger contractures, or where a defect is situated in the midst of scar tissue.

Fourth, by pedunculated flaps from distant parts, called the Italian method. This may be done either by a single or double transfer. It is usually easy to secure sufficient tissue by using flaps from distant parts, but the constrained position necessary in order to utilize these flaps is exceedingly irksome to the patient, and many are unwilling to endure the discomfort.

In all sorts of plastic operations it is advantageous that the patient should be in the best possible physical condition, and no plastic operation should be undertaken on those with active local disease still present. Asepsis rather than antisepsis should be maintained throughout the operation, and during convalescence. The tissues should be treated with the greatest consideration. Sharp cutting instruments must be used to avoid unnecessary injury to the tissues. The flaps should be handled with special forceps or small sharp hooks. The area into which the flap or graft is to be transferred should be perfectly dry, and all hemorrhage checked, as many failures are due to a blood clot collecting beneath the transplant, which prevents the early formation of a new blood supply. An accurate estimate of immediate and subsequent tissue shrinkage must be planned for. Accurate apposition is desirable as prompt healing minimizes scar tissue.

One of the most important points in plastic surgery when tissue of any kind is transferred, is that there be no tension either on flaps or on free grafts. Never leave a suture in place which blanches the transplanted tissues, as it is better to gain only a portion of the necessary distance than to jeopardize the whole flap. The use of pedunculated flaps is especially valuable when a pad of fat is required in addition to the whole thickness of the skin. The shape of the flap must correspond fairly accurately to the defect which it is to cover. Thin flaps are so pliable that they can easily be adjusted to fit a defect of almost any shape, but, especially in rhinoplastic operations, it is advisable to outline the flap from a carefully calculated pattern.

The skin of pedunculated flaps, as well as of whole thickness grafts, must be chosen with some regard to the area into which it is to be placed. The flap should be cut at least one-third larger than the area it is to fill, and this equally applies to grafts of whole thickness skin. The shrinkage of both flap and graft is in the direction of the elastic fibres. Normal skin is necessary for a successful flap, as any scar on the edge of a flap will usually slough, and a scar running across a flap will completely cut off the circulation beyond it. Always excise the scar if possible along the edges to be sutured, as the healing will be much more satisfactory.

The pedicle should be as broad as possible. Always aim to have the pedicle very close to the loss of substance. The long axis of the pedicle should be in the same direction as the axis of the flap in the new situation. The pedicle of a flap should be in the same line as the area to be filled. The elasticity of the skin will allow a curved flap to assume a straight position without difficulty.

As a general rule the flap should not be longer than two and a half or three times the width of the pedicle. The pedicle should not be twisted enough to interfere with the circulation of the flap. The flap should be made of the skin and subcutaneous fat, and in some large wounds the deep fascia may be included. The amount of fat should

be somewhat thicker than is actually necessary to fill the defect, as the excess is taken care of by subsequent shrinkage. It is unwise to include muscle with the skin and fat flap to be shifted. The shifting of muscle, etc., should be done separately. A flap may be cut much thinner if its pedicle contains a main artery, and it is of advantage to have the artery. However, a main artery is not essential if the flap is thick and includes enough smaller vessels for its proper nutrition.

Twisting or too much tension on a pedicle may cause the shutting off of circulation and subsequent death of the flap. There is sometimes death of a pedunculated flap which has an excellent blood supply due to the lack of drainage from the flap. In other words, the flap is choked by the blood entering it and being unable to get out promptly. This is especially to be feared if the pedicle contains a main artery. This danger is overcome by scarifying the flap to allow surface drainage until the proper vessel drainage is established. Scarifying for drainage is not necessary in whole thickness free grafts. Perforation of the grafts is essential, however, to allow the escape of blood or serum which may collect beneath the graft.

When there is doubt about the circulation in a long narrow flap, it is advisable to separate it from the deeper structures but to leave it attached at each end. Keep it separated from its bed by rubber protective, or by covering the bed with Thiersch grafts, and then after two or three weeks cut one pedicle and transfer the flap. As a rule it is best to wait from 10 days to two weeks before amputating the pedicle of a flap. This may be done by notching on each side of the base and thus gradually cutting off the circulation of the pedicle or the amputation may be done at one time, and after the pedicle is cut through it should at once be fitted into its proper position, as in this way a better result can be obtained with little, if any, loss of the tissue in the pedicle. The area from which the pedunculated flap is taken may be closed with sutures if the skin is lax, or after undercutting and sliding. If closure is not possible on account of the size of the area, then the defect may be covered with skin grafts, preferably of the Thiersch variety. Immobilization of the part with plaster, crinolin, or splint is essential, and the dressings next to the transplanted tissue should be soft and very carefully applied.

Flaps of normal tissue are often successfully shifted into the midst of scar tissue, but the circulation of these flaps should be especially good. A graft of whole thickness skin may also be placed successfully in the midst of movable scar tissue, and accomplish its purpose. The result in these cases being that the graft is more stable than the tissue which surrounds it, and it also follows that the scar becomes more resistant as the tension is relieved.

On a part completely covered with scar, as is often seen on the face, much can be done by the gradual shifting of the scar tissue itself, but this must be done very slowly, and with the greatest care, sometimes

only a fraction of an inch being gained at one operation. It is a waste of time to attempt to shift pedunculated flaps of scar tissue.

In plastic work I prefer to use small cervical needles for the deep sutures when they are necessary, and catgut for the suture material. For the skin I find the corneal needle satisfactory, and use horse-hair, very fine silk, silkworm gut, or silver wire, depending on the indications. In cleft palate work I find that silkworm gut and horse-hair for the hard and soft palates and fine silk for the uvula are most satisfactory. Special small curved needles are used for this work. Very fine catgut should be used for ligatures. It is rare in plastic surgery that we encounter a deformity which cannot be helped by logical surgical methods. At best we can only accomplish a certain amount, trusting in nature to complete our work.

BONE AUTOGENOUS GRAFT IN THE TREATMENT OF FRACTURE OF THE GREATER TUBEROSITY OF THE HUMERUS

By Wilson T. Davidson, M.D.
Camp Hospital, Laredo, Texas
Major, Medical Corps, U. S. Army

Fracture of the greater tuberosity of the humerus is not such an infrequent occurrence as some might suppose; this has been demonstrated by the more frequent use of the X-ray in examining a class of injuries that would at first glance be treated as a severe contusion of the shoulder. While the majority of these injuries are due to a direct violence, there is a certain percentage that are due to a forcible contraction of the muscles. In cases where there is some doubt as to the diagnosis, a careful differentiation should be made from subacromial bursitis, since these two conditions present many symptoms in common. However, in the case of fracture, a history of violence or the use of the X-ray would make clear the diagnosis at once.

In presenting himself for treatment the patient will usually give the following symptoms: Inability to abduct the arm, movements backward and forward slow and painful. Frequently there is crepitus elicited by these movements, though by no means is this always the case.

It may be well to review briefly the anatomy of the parts concerned in these cases, thus making clear the reasons for the symptoms presented. It will be recalled that the supraspinatus, infraspinatus and teres minor are all attached to the greater tuberosity of the humerus, the action of the first being abduction and that of the last two being external rotation. While the deltoid is a powerful abductor of the arm, the use of this muscle would be attended with great pain in the cases under consideration, owing to the trauma.

As to the question of treatment—before the use of the X-ray these cases were treated as a severe contusion, and later on have furnished a large percentage of chronic dislocation of the shoulder-joint. Left to itself, in cases where there is complete separation, the muscles atrophy, the bone is drawn up under the deltoid, and there is inevitably a partial loss of function of the shoulder-joint. This is worthy of serious consideration when one recalls the manifold motions of this joint, during nearly every moment of activity.

Three methods have been proposed to remedy this injury[1]: (1) Resection; (2) suture; (3) immobilization. The first, in my

[1] Des fractures par arrachement de grosse tuberosité de humérus, par Paul Forget. Thèse pour le Doctorat en Méd., Faculté de Paris.

opinion, can be dismissed as not being worthy of serious consideration. The second method, if it could be carried out satisfactorily, leaves nothing to be desired. Unfortunately, however, this has not always been easy to attain. The suture material used, whether it be kangaroo tendon or chromicized catgut, has not always held the fragments in place; and silver wire when used has been known to cause future trouble. The third method mentioned will yield a good result in some cases—those in which there is not a complete displacement of the bone and in which external rotation and abduction will bring the parts in complete coaptation. All such cases should be treated by this method.

In 1903, W. W. Keen [2] reported a case of fracture of the greater tuberosity in which the fragment was drawn up between the head of the humerus and spine of the scapula. The fragment could not be brought into its normal position by any kind of position or dressing; it was replaced through an open incision, and held there by means of two wire nails, 7.5 cm. in length and 2 mm. in diameter. The result was a complete restoration of normal function. It is believed that the method of using bone grafts in these cases will prove entirely satisfactory in injuries in which there is complete detachment of the lesser fragment. The parts can be exposed readily with very little injury to muscle or nerve and the fragment brought into apposition and so maintained; the grafts will favor a more ready union, and it would seem that there should be a complete restoration of good function. It may not prove uninteresting to report a case in which this method was used which came within a recent experience of the writer:

> Private L., 122nd Company, Coast Artillery Corps; aged twenty-eight, years of service six and seven-twelfths, enlisted first time June 5, 1905. Previous history negative. Present illness: On morning of December 11, 1915, had started up concrete steps at the rear entrance to Barracks at Fort Hamilton, New York, when he slipped on the ice covering the steps and fell forward towards his left side. There was an iron railing on the right, and the soldier made an ineffectual attempt to grasp it with his left hand, but his hold slipped, the railing being covered with ice, and he fell heavily forward and upward, striking the left shoulder against the edge of concrete step. While lying in this position he made an attempt to grasp the railing with left hand when severe pain was elicited in the shoulder. Upon admission to hospital an examination was

[2] Fracture of the Greater Tuberosity of the Humerus with Dislocation of the Humerus into the Axilla. Immediate Reduction of Dislocation on Seventh Day; Nailing of Fragment of Tuberosity in Place. ANN. OF SURGERY, vol. xxxvii, May, 1903.

made immediately by Captain John R. Bosley, Medical Corps, and there was found to be a loss of power of abduction; forward and backward motion slight, attended with considerable pain and a sort of clicking or cripitant sensation experienced by the patient. An X-ray picture made at the time showed a fracture of the greater tuberosity with complete separation (Fig. 1). Major Joseph H. Ford, Medical Corps, United States Army, Surgeon of the Coast Defence District, examined the case, rather favored the idea of operative interference, and it was due to his courtesy that the soldier was sent across to me at Fort Wadsworth with that end in view.

FIG. 1.—Diagrammatic sketch showing relative position of fragments found at operation.

Operation.—On the eighth day following accident, the fracture was exposed through a long incision extending downward from the inner border of the acromion process and by separating the fibres of the deltoid by blunt dissection. The fracture was found to extend forward to the groove for the long head of the biceps; the anterior border of the detached fragment was elevated 5 cm. and the posterior about one-half that distance. By means of abducting the arm and rotating it posteriorly, and grasping the muscles at their attachment to the tuberosity with tissue forceps, the detached portion was gradually brought into place, and while held firmly in this position

holes were drilled 4 cm. in length and 4 mm. in diameter, and about 2½ cm. apart. The wound was now packed with hot compresses while a fragment of bone was removed from the crest of the tibia 4 cm. in length and 1 cm. in thickness at its widest portion. The fragment was now split longitudinally into two equal pieces and the angles of these were rounded. After again replacing the tuberosity these grafts were inserted into the holes previously prepared. This means was found effectual in holding the parts in good position (Fig. 2). A rent in the capsule was repaired with chromic catgut, the deltoid brought together with a continuous plain catgut and the skin with a continuous silk suture. The arm was placed in a Velpeau bandage, which during the first few weeks was re-enforced with plaster. At the end of four weeks all dressings were removed except a triangular sling for the forearm, and massage and passive motion begun. Active motion was begun a week later and finally the motion of exreme abduction was practised. Upon return to duty at the end of about two months, soldier could abduct arm completely, and there was general restoration of function.

It is believed that the method herein described should be considered the method of choice in all cases of this fracture in which there is complete detachment with the fragment drawn upward beneath the deltoid.

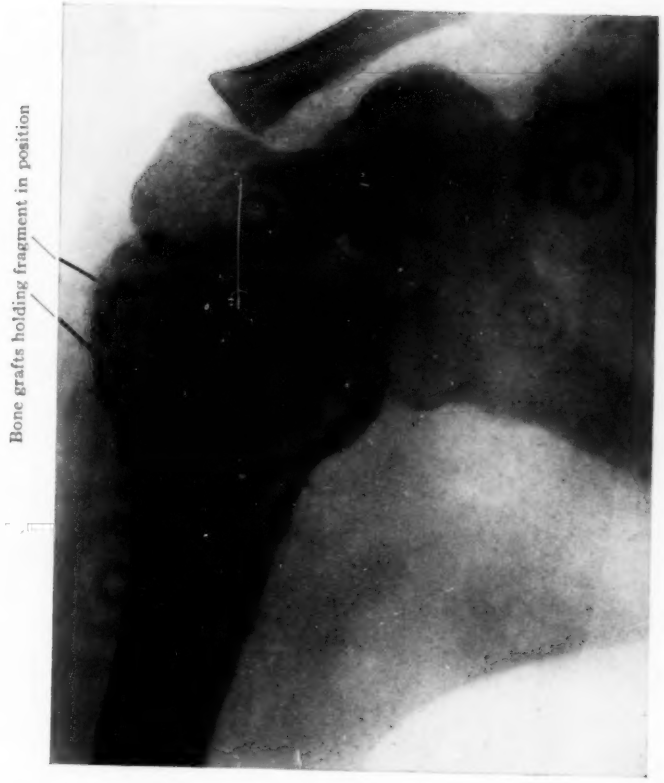

FIG. 2.—X-ray photograph taken five days after operation, showing readjustment of fragment.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting, held March 5, 1917

The President, Dr. Charles H. Frazier, in the Chair

X-RAY TREATMENT OF CARBUNCLE OF FACE

Dr. George G. Ross presented a woman, sixty-two years of age, who was admitted to the Stetson Hospital on December 23, 1916. Her history showed that on November 23, 1916, she had first noticed a "small pimple" in the right temporal region just anterior to the ear. This grew very hard and painful, enlarged rapidly, and spread to the cheek and side of the neck. The carbuncle was incised, but grew rapidly worse. On admission the patient showed on the right side the face a hard, deeply congested swelling, containing numerous small openings from which a little pus oozed, showing slough beneath. This swelling extended from just anterior to the ear around under the eye and down the neck to just above the clavicle, involving the whole side of the face and cheek over to the edge of the mouth and nose. This is well shown in the accompanying photograph (Fig. 1).

The patient's general condition was poor. Her previous history of polyuria and pruritus suggested diabetes, and there was also a history of glycosuria. Sugar was, however, not shown in the urine until January 4, 1917, and then in small quantity (.277 per cent.). Later it was more abundant and has been in evidence since her discharge from the hospital. The temperature on admission was 101 degrees and never ran above this, being practically normal after the third week. Pain was not marked and the carbuncle was markedly insensitive to handling. The process was exactly such a slow sloughing with subacute infection as is often seen in diabetic conditions.

The patient was placed upon liquid diet with milk and eggs freely given. Flaxseed poultices were applied and continued until January 18, 1917. Local treatment was from the first confined to cleansing, removal of detritus, and touching the openings with tincture of iodine. The first X-ray treatment was given on December 27, 1916, and three subsequent ones on January 1, January 5, and January 18, 1917, respectively. Each one was of ten minutes' duration and given without

filtration. A five milliampere current backed up against a 4½-inch spark. After each treatment there was a marked reaction. Improvement was noted after the first treatment and each subsequent one (Fig. 2). The inflammatory swelling began to subside and the carbuncle literally dried up. The pictures show this better than it can be described. The local process made an uninterrupted recovery. In the second week the swelling below the angle of the jaw became so marked that it seemed that incision would be necessary, but improvement under the X-ray made this unnecessary. The patient's general condition rapidly improved and she was able to be up on January 18, 1917. A troublesome diarrhœa and pains, probably phlebitic, in the lower extremities delayed her complete recovery.

GALL-STONE ILEUS

Dr. George G. Ross presented an elderly woman, who was admitted to hospital December 3, 1916, with the history that about twenty-four hours before admission she was seized with sudden cramp-like pain in central abdomen. There was no radiation and it increased in intensity. Nausea and vomiting started almost immediately and continued at very short intervals until admission. At first the vomitus was yellowish, but later it became dark brown and of a fecal odor. It was forcible in type. Patient's bowels moved twice after the onset of sickness without any medical agents. There were no cardiac, pulmonary or renal symptoms. According to her statements she had always been in good health except for an attack of severe upper abdominal pain about one year ago, lasting for two or three days and accompanied with nausea and vomiting. Has never been jaundiced. Has never noticed clay-colored stools. She has never been troubled with gastro-intestinal symptoms aside from the above, and occasional gaseous eructations. Physical examination reveals an elderly white female, apparently very acutely ill. Frequent vomiting of dark fluid material with intense fecal odor. Pulse is good in volume and regular. Heart and lungs negative to rapid examination. Abdomen pendulous. There is no point of special tenderness, but a general soreness. There are no palpable masses. Inguinal and femoral hernial orifices free.

The abdomen was opened by a right rectus incision just below the level of the umbilicus. Considerable free blood-stained fluid within the peritoneal cavity. Peritoneum slightly injected. Hernial orifices free. In the pouch of Douglas was a loop of ileum, in the lumen of the most dependent portion of which was a mass about the size of a walnut. Intestine slightly dilated above the obstruction. Bowel incised over the mass which was expressed through the incision. It appeared

FIG. 1.—Carbuncle of cheek.

FIG. 2.—Carbuncle of face. Condition after two applications of the X-ray.

to be a gall-stone. The bowel was closed by fine catgut suture. Peritoneum stitched over the line of incision with linen thread. To palpation the gall-bladder was very much contracted and the lumen practically obliterated. There were old adhesions between the gall-bladder and bowel. The abdomen was closed without drainage.

Except for a moderate superficial infection her subsequent progress of recovery was uneventful and she was discharged at the end of five weeks.

The obstruction in this case was due to two conditions: First, the diminution of the lumen by the large stone; and second, to the sharp angulation of the gut caused by the weight of the stone.

PROBLEMS OF PLASTIC SURGERY

Dr. John Staige Davis (of Baltimore) read, by invitation, a paper with the above title, for which see page 88.

Dr. John B. Roberts said that of late years he had been more interested in what might be called cosmetic constructive and reconstructive surgery than in strategic and substitutive plastic surgery. The last two are often valuable in obtaining access to deeper organs and in supplying physiologic substitutes for structures put out of commission by operation or disease. Cosmetic surgery affords operative relief in congenital deformities and deformities due to loss of tissue. To illustrate some of the results he had brought a patient and a few photographs of other patients to give an idea of what he considered good plans of treatment. This boy, now eleven years old, had been under his care for successive operations since he was about five years old. He lost, by cicatricial contraction after deep burns, the use of his left thumb, which is shown by the photographs (Figs. 3 and 4). In addition his left ear was deformed in its lower portion by being buried in cicatricial tissue close against the lower part of his skull. He had no chin, because the deep sloughing and scarring of the neck had drawn the lower jaw close to the front of the laryngeal region. His lower lip was attached to the mental region so that it was dragged outward allowing saliva to flow over. His mouth, therefore, could not be closed and he could not lift his head from his chest (Fig. 5). The thumb, which was extended and abducted and attached to the front of the wrist by contraction, was by a succession of operations liberated by sliding tissue from the dorsal and palmar surfaces of the forearm into the gap left when the flexed wrist and the movable thumb were after incisions put in proper position. A portion of the gap was closed by a large flap obtained by attaching the hand and forearm to the abdomen for a couple of weeks. He now has a fairly movable thumb and a straight wrist (Fig. 4). By sliding and transferring pedunculated

flaps from the sides of the neck, the head was liberated and a chin made. The everted lower lip shown in the original photograph was freed and replaced so that he could close the mouth; and a new external portion made to the lip by utilizing flaps from the outer portions of the upper lip and some of the flap taken from the anterior belly wall to fill in the space left when the thumb was liberated. Sliding flaps were used to make a new lobe to the ear. This was accomplished by using a folded flap with penetrating mattress sutures to form a lobe. The final result obtained is shown in Fig. 7.

The method of transporting a flap from abdomen or thigh is shown in Fig. 8, which shows a large piece of skin and superficial fascia removed from the thigh of a patient and attached to the left hand to be carried to the face to make the lower part of the nose, lost by syphilis. Figs. 9 and 10 show how the ponderous nose due to rhinophyma or hypertrophic acne may be relieved. This man's nose was shaved down to a proper shape by a razor and a large Thiersch epithelial skin graft from the thigh was placed upon the end of the nose. The photograph was taken very shortly after the skin graft was placed in position. The cure was very satisfactory.

Figs. 11 and 12 show the value of adipose tissue grafts to restore the contour of the cheek. The patient had had, since early manhood, a deeply attached furrow scar of the cheek, due to a kick by a horse. By splitting open the tissues, incising the scar tissue latterly beneath the skin and inserting a free flap of fatty tissue from the front of the abdomen, he was able to fill out the cheek as shown in the picture. This, it will be seen, was made a little over-full because shrinkage is sure to take place later. The second photograph was made about three weeks after the operation.

Dr. Francis T. Stewart said, in regard to æsthetic surgery, that one of the principles which should be emphasized is the taking of the tissue from the immediate neighborhood of the defect whenever that is possible. The secondary changes which take place in a graft taken from a distance sometimes make the repair as unsightly as the defect. The Italian method of transplantation was until recently the only method of bringing parts from a distance, but this has fallen into increasing disuse because of the employment of the free transplantations. In the correction of defects especially of the face which is the only part, at least in man, which can always be seen, tissue from the scalp can be used to advantage. Fortunately the hair follicles are preserved and the hair grows and covers up whatever irregularities the surgeon may not have had the skill or the opportunity to correct.

ACUTE PERFORATION OF GASTRIC AND DUODENAL ULCERS

Dr. Emory G. Alexander read a paper with the above title, for which see page 72.

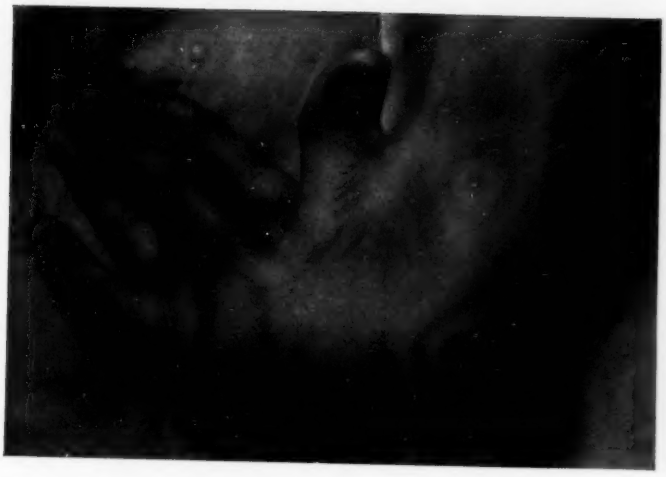

FIG. 3.—Deformity of thumb and wrist from scar of burn in child of six years, due to accident one year before.

FIG. 4.—Plastic operation on thumb, showing condition three months after operation (see Fig. 3). Notice flap swung from back of wrist and forearm to release thumb.

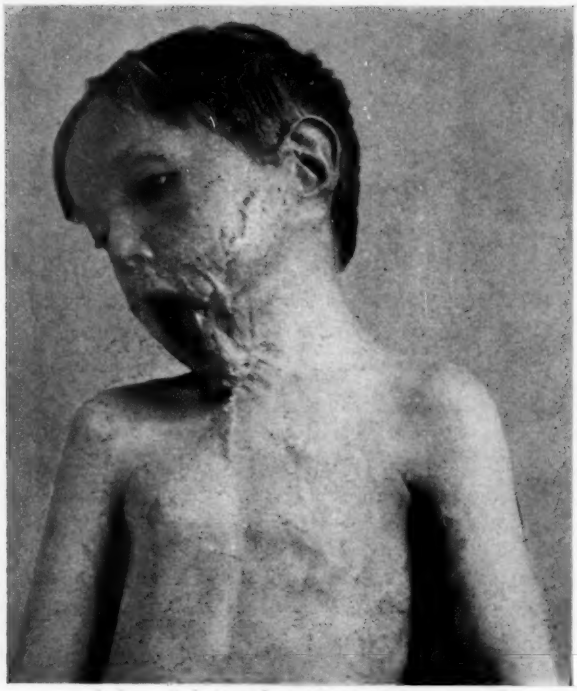

FIG. 5.—Deformity of mouth, chin and ear from burn one year previously.

FIG. 6.—Showing improvement in face three months after operation.

FIG. 7.—Showing condition of patient of Figs. 5 and 6, six years after operations. Boy now twelve years old.

FIG. 8.—Mass obtained from thigh attached to edge of hand to be transferred to nose as a rhinoplastic procedure.

FIG. 9.—Rhinophyma.

FIG. 10.—Result of graft after removal of rhinophyma.

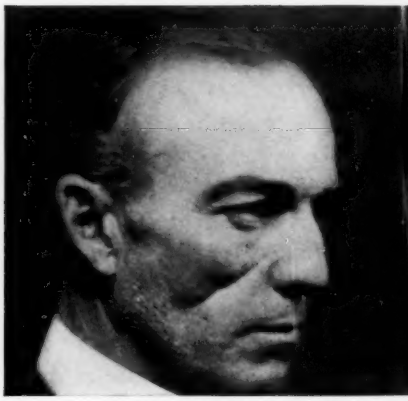

FIG. 11.—Furrow scar of cheek attached to subjacent bone.

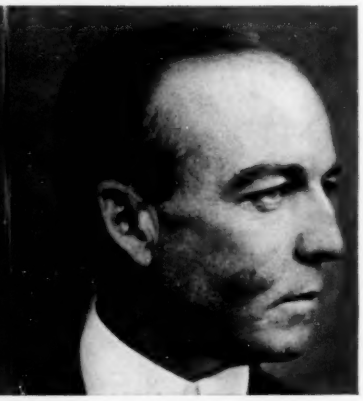

FIG. 12.—Scar freed from bone and cheek filled out by a free transplant of fat taken from abdominal wall.

HISTOLOGICAL EVIDENCES OF GROWTH CHANGES IN TRANSPLANTS

DR. DEAN LEWIS, of Chicago, read by invitation a paper with the above title, of which the following is an abstract:

There is still considerable discussion as to the histological changes occurring in transplanted tissue of different types and their significance. We know that certain rules must be followed and certain technical errors avoided if the transplantation is to be successful, but we do not as yet know positively upon what the life of transplanted tissue depends. A number of different conclusions have been drawn from the study of much the same material by different men.

Various views have been expressed concerning the fate of the different elements in bone transplants, and in many instances much the same type of experiment has been made and the preparations have been stained in much the same way. One observer comes to the conclusion that periosteum is markedly osteogenetic, while another observer believes that the transplanted tissue acts merely as a scaffolding for developing osteoblasts and that therefore boiled bone, homo- and heterotransplants do as well as an autotransplant. It is difficult to reconcile the different views which have been expressed. The difficulties of interpretation of histological preparations are indicated by the diversity of conclusions arrived at in the study of preparations of much the same kind. It is almost impossible in some cases to correlate histological appearances with function and growth potentialities.

In considering transplants of bone, tendon, fascia and nerves, we find that degenerative and regenerative changes occur in all.

The regressive changes occurring in a bone transplant are dependent upon the physical properties of compact bone which does not permit of early and extensive permeation of serum. The unossified portion of a transplanted segment of bone and the periosteum and contents of the medullary canal, porous spaces and Haversian canals, are readily permeable to lymph and consequently are more apt to live. The compact bone is apt to die. As far as can be determined by histological examination of transplanted bone, the greater part of the compact bone dies, and this is replaced slowly by the so-called "creeping substitution" by bone cells of the compact bone which have not died and by cells from the periosteum and endosteum.

Ivory pegs or dead boiled bone may be used as intramedullary splints, the ends of the fragments being placed in immediate contact or somewhat separated over such a splint. In these cases the peg or dead bone may be replaced by the newly formed bone. Such material cannot be used to bridge a long defect, for substitution, in my experience does not take place in dead tissue used to bridge a long defect.

Degenerative and regenerative changes occur in transplanted tendon. The degenerative fibrillæ in a tendon transplant are replaced by tissue formed by proliferation of the peritendineum externum and internum. The regenerative changes in the transplanted tendon are dependent upon the early assumption of functional activity. Segments of tendon, transplanted into

subcutaneous fat roll up and become shrunken, the fibrillæ becoming distinctly smaller in size and staining poorly, while segments of a tendon transplanted into a defect in a tendon which is made to functionate early undergoes distinct regenerative changes as indicated by an increase in size and distinct histological evidences of growth.

All transplants must assume function early. William Roux several years ago stated that the fate of transplanted tissue was dependent upon whether or not the transplant was made to assume functional activity.

Tissue such as fascia and cartilage which physiologically may be placed rather low in the scale perform a number of different functions, and may be transplanted in different ways and places and still survive. Cartilage as shown by Davis transplanted into subcutaneous tissues will survive, while bone transplanted in this way will be gradually absorbed. Fascia does not tend to undergo the same changes as tendon. The degenerative changes occurring in transplanted fascia, which are mostly fatty, are apparently directly proportionate to the size of the transplant. In large fascial transplants transplanted into dural defects fatty changes have occurred in the center with subsequent cicatricial substitution. These changes are due to failure of serum to permeate to the center or delayed reëstablishment of vascular circulation at this point.

Fascia and cartilage may be successfully transplanted into places and under conditions which would result in gradual absorption of tendon and bone transplants.

In nerve regeneration the degenerative changes occurring in the distal end of the proximal end and throughout the distal segment are followed by regenerative changes which are very important. Degeneration of the axis cylinders and myelin sheaths are followed by proliferative changes in the neurilemma sheaths which lead to the formation of the so-called protoplasmic bands. These bands form the conduits down which the regenerating axis cylinders of the proximal stump pass, and are the essential determining factor in nerve regeneration. Axis cylinders reform after section of the spinal cord, but do not pass the point of section because no bands are formed and the regenerated axis cylinders form a network at the level of section.

Experimental work would indicate that the hyperplastic nuclei of the developing protoplasmic band can grow in vitro, while the resting nuclei die. This experiment would indicate that a nerve graft to be successful should be transplanted after Wallerian degeneration has commenced.

After the neurilemmal nuclei has passed back to the resting stage it is doubtful whether the protoplasmic band stage can be reproduced again. and this may account for the number of failures of secondary nerve suture after the lapse of considerable time.

Roux's law has much to do with the fate of a transplant and failure to keep it in mind accounts for the many different conclusions which have been drawn concerning the fate of transplanted tissue. Interpretations of the histological findings often differ because of the difficulty of correlating structure and function.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting, held February 14, 1917

The President, Dr. Charles N. Dowd, in the Chair

MYOSITIS OF CHEST WALL

Dr. James M. Hitzrot presented a man, twenty-six years of age, who was admitted to the New York Hospital, December 27, 1916, complaining of a swelling on the left side of his chest. His present illness began December 7, 1916, with chilly sensations, fever, and the appearance of a tender mass over the left side of the chest near the edge of the ribs. The mass was soft, not red nor inflamed. It was acutely painful, "like a boil," and he was unable to take a deep breath or move the left arm freely. He was sent to the University Infirmary at Ithaca, where an X-ray examination was reported as negative. The Wassermann was negative and his blood count was stated as not normal. Under ice-bags the mass became firm and the pain and swelling decreased somewhat. He was in the Infirmary two weeks, with an evening temperature of 101° during that time. There was no history of injury and no local infection elsewhere. His past and family history gave no essential features for consideration. On examination there was a swelling about 12 by 10 cm. over the cartilaginous portion of the eighth, ninth, and tenth ribs, extending back along the ninth rib on the left side (Fig. 1). The swelling was symmetrical, the skin normal in appearance, not reddened. The mass was made more prominent by any movement which projected the ribs forward. It was not altered by coughing; the skin over it did not feel hot and was freely movable. The swelling was not particularly tender, was firm, hard, not fluctuant, and could not be readily defined at its margins. His blood count was: Hæmoglobin, 81 per cent.; red blood-cells, 5,652,00; white blood-cells, 17,000; polymorphonuclears, 62 per cent.; small mononuclears, 32 per cent.; large mononuclears, 3 per cent.; transitional types, 3 per cent., with no abnormal cells. An X-ray picture showed no recognizable lesion in the ribs. The diagnosis was not obvious. Some infectious process beginning in the rib seemed most probable, although a careful X-ray examination showed no bone lesion.

Operation.—On December 30 a 5-inch incision was made over the swelling in the line of the ninth rib. When the muscle plane was exposed the fascia was œdematous. The muscle itself was grayish white in color, very firm, almost cartilaginous in character, and very markedly altered. The external oblique muscle was about three to four times its normal thickness in the involved area. The underlying bone was uninvolved. At one point

in the cartilage there was a little pitted area which did not look normal. This was excised, although the cartilage did not seem to be involved. The wound was then packed wide open after taking a piece of muscle for histological examination and a culture from the œdematous fascia. The pus gave a pure culture of staphylococcus aureus. The pathological report by Dr. Elser was *interstitial myositis,* with extensive infiltration of the muscle bundles and alteration in the muscle fibres. The section of cartilage removed showed no pathological change.

CENTRAL FRACTURE OF THE ACETABULUM: ANKYLOSIS OF THE HIP DUE TO BONY FUSION BETWEEN THE GREAT TROCHANTER AND THE ILIUM

Dr. Hitzrot presented a man, aged thirty-two, who was admitted to the New York Hospital, January 6, 1917, with a history of an injury to his left hip, August 9, 1916. He was taken to a hospital and kept in bed for four weeks and discharged one week later. He states that X-ray plates were taken and that they showed that nothing was broken. Upon examination at the New York Hospital it was seen that the left hip was ankylosed, there being no motion in that joint. The left trochanter was more prominent than the right and seemed closer to the midline. The left leg was apparently shorter than the right. Measured from anterior superior spine to internal malleolus the left leg measured 1.3 cm. longer than the right. The region of the great trochanter was occupied by a bony mass which prevented making any accurate estimation of its relation to Nélaton's line, Bryant's base line, or the projection line of Schumacher. An X-ray picture showed a fracture of the acetabulum with projection of the fractured area into the pelvis and apparently bony repair of the fracture (Fig. 2). Between the trochanter and the side of the ilium was an ill-defined mass of bone which was not correctly interpreted until after the operation.

Operation (January 12).—Through an obtuse angle incision from below the outer superior spine to the trochanter and then down the thigh the region was exposed. The trochanter could not be definitely outlined, as its top was capped by a mass of new bone. The neck of the femur was then determined, and with an osteotome the trochanter, etc., was cut away from the shaft, after which rotation and flexion of the femur was readily obtained. The trochanter, however, could not be moved, as it was firmly fixed to the rim of the acetabulum. It was freed by an osteotome and removed after separating the attachments of the external rotators and the gluteus medius. These muscles were then attached to the periosteum of the shaft by chromic stitches and the wound closed. A small rubber tissue drain was inserted.

The wound healed by primary union and the patient was up and about on the fifth day after operation. Since that time motion has constantly increased and the patient goes about more satisfactorily than before. It is yet too early to determine the final outcome of the case. The specimen

FIG. 1.—Showing location and appearance of a localized myositis of the left chest wall.

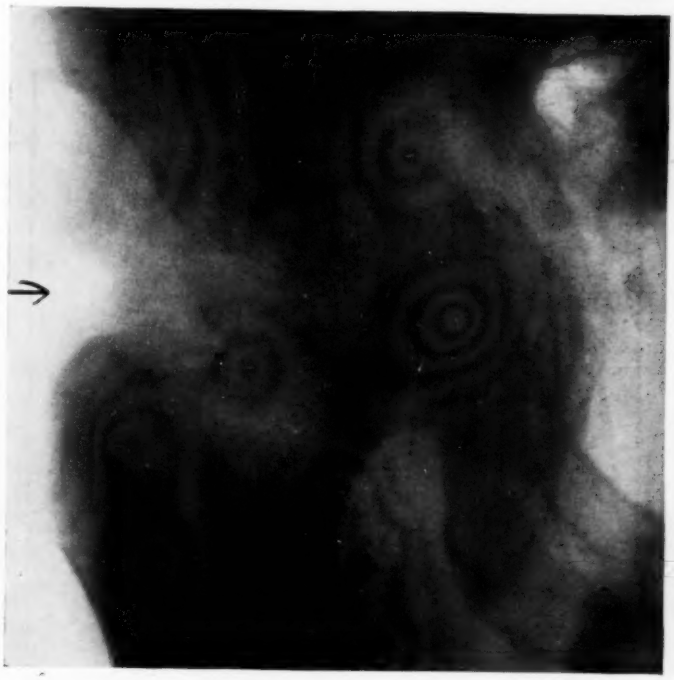

FIG. 2.—Central fracture of the acetabulum; repair with ankylosis.

FIG. 3.—Diacondylar fracture of humerus, lateral view.

FIG. 4.—Diacondylar fracture of humerus, anteroposterior view.

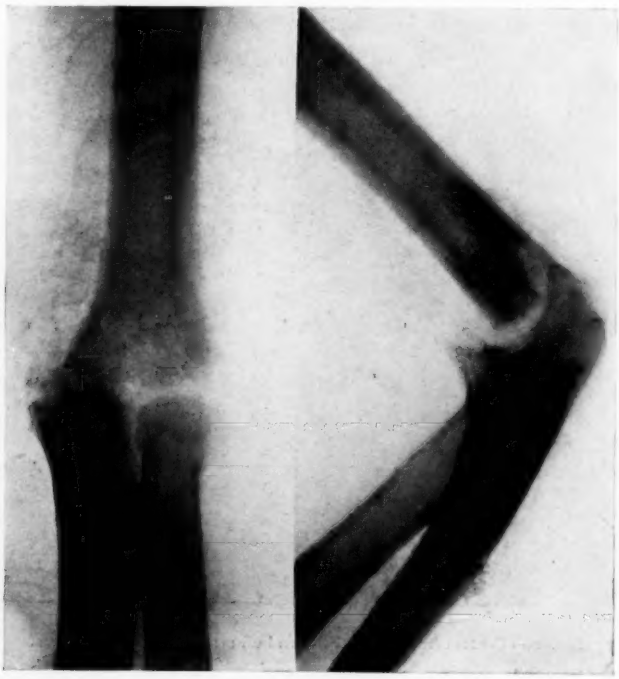

FIG. 5.—Showing results obtained by arthroplasty.

removed consists of the trochanter, a mass of new bone between it and the ilium, and a small portion of the ilium just above the acetabular rim, and shows the cause of the ankylosis.

The case is shown as a rather rare type of injury, with an especially rare complication, namely, the union between the ilium and the trochanter. Motion at the hip as an early essential of his treatment, had the condition been recognized, might have kept the two bony surfaces from uniting as they did.

COMPLICATED DIACONDYLAR FRACTURE OF THE RIGHT HUMERUS (OLD) : ARTHROPLASTY

DR. HITZROT presented a man, aged twenty-nine years, who was admitted to the New York Hospital December 30, 1916, with a history that, sixteen days before admission, he had fallen about twelve feet, landing on the palm of his outstretched right hand and causing a fracture at the right elbow. He states that the skin over the outer side of the arm was broken and the bone was protruding. He was taken to a hospital and the arm was bandaged on a straight splint. Examination showed a complicated fracture at the elbow-joint, involving the lower end of the humerus, with displacement of the fragments and the joint posteriorly. The X-ray showed a diacondylar fracture with comminution and splitting of the articular surface and displacement and rotation of the trochlea internally and the capitellum externally and the posterior displacement of the fracture (Fig. 3). On January 5, 1917, twenty-two days after the injury, he was submitted to operation because anything except open operation could not produce a satisfactory result.

A four-inch incision was made over the external aspect of the arm, exposing the site of the fracture. The lower end of the humerus, the fractured bone fragments, and the olecranon were found posterior in a position similar to that in a posterior dislocation. The capitellum was displaced outward, rotated postero-externally, and there was a mass of new bone on the posterior portion of the humerus which bridged the gap between the fracture and the shaft proper. The new bone and the capitellum were removed. A three-inch incision was then made over the internal aspect of the joint, the ulnar nerve exposed and retracted, and the fragment of the trochlea, which was displaced inward with the articular cartilage pointing down and in and the fractured surface pointing up and back, was exposed. This, likewise, was united to the shaft of the bone by a mass of osteoid tissue. The trochlea was then removed, as was the new bone. The lower end of the humerus was dislocated into the external wound and a thin chip of fractured surface removed with the saw. With a gouge an olecranon fossa was made in the expansion of the humeral shaft. A piece of fascia lata, measuring about 10 x 7 cm., was then taken from the right side of the thigh. This was carefully approximated about the lower end of the humerus and fastened in position with chromic stitches. The olecranon fossa was

then placed in contact with the lower end of the humerus so that the elbow-joint was reconstructed. The wound was closed in layers, using a piece of rubber dam drainage from the upper angle of the outer wound, and the arm was put up in anterior molded plaster splint. The condition found at the operation did not permit of reduction and an arthroplasty had to be resorted to.

His convalescence was uninterrupted (Fig. 5). He was carrying a weight and using his arm without a splint two weeks after the operation. It is yet too early to determine the amount of function which will result, and the case is shown to arouse some discussion as to the most appropriate method of handling any injury of this particular type.

Dr. Howard Lilienthal said that he had performed arthroplasty in cases of this kind and had noted excellent functional results without the interposition of fascia. While the fascial interposition may be of benefit, its value does not appear to have been proved.

Dr. William Darrach agreed with Dr. Lilienthal. He thought in these elbow fractures it certainly is worth while to try simple removal of the fragments. if it is impossible to replace those fragments; even after twenty-two days it is quite well worth trying to replace the fragments in position.

RESULTS OF PULMONARY LOBECTOMY

Dr. Howard Lilienthal presented three patients to illustrate the end-results following pulmonary lobectomy. The first patient, a boy, six and one-quarter years old, was operated February 22, 1914, the entire right lower lobe having been extirpated. His history was reported in the Annals of Surgery, June, 1914, and July, 1916, and now, three years after his operation, with the exception of the cicatrix the boy looks perfectly normal and symmetrical and that all the motions of body and arms are possible.

The second patient, a boy ten years old, was operated March 4, 1915, and reported in the Annals of Surgery, July, 1916. The right lower lobe was extirpated for indurative pneumonia with bronchiectasis and peribronchial abscesses. The X-ray appearances in both these cases were those of lower lobe infiltration. In the last patient a little pus had been withdrawn by another physician through an aspirating needle, and the case was supposed to be one of empyema, the differential diagnosis being made by the X-ray. In both these cases the operation was performed through a wide, seventh-space intercostal incision, using the rib-spreading retractor. The hilum of the lobe was crushed and then ligated and carbolized, the stump being steadied by means of a chromicized catgut suture which was led out of the wound and held in place by means of a safety pin, this to prevent so-called mediastinal flapping. This second patient also is normal in development and has perfect function of chest and arms.

The X-ray in the second case shows, now two years after operation, a chest almost normal.

The third patient, B., is a woman forty years old. She had been suffering for more than two years from lung abscess and suppurative bronchiectasis of a non-tuberculous nature following a tonsillectomy in general anæsthesia. She was referred by the late Dr. Charles H. Richardson. The patient was coughing up tremendous quantities of pungently foul sputum; she said as much as a quart in twenty-four hours. Her case was, indeed, desperate. She was not able to keep house, and whenever she found a boarding place she was soon asked to leave. The X-ray in this case showed a dense shadow in the middle and lower lobes of the right lung. The left chest, except for a few shadows which indicated bronchial glands, showed nothing abnormal. She was operated upon in Mt. Sinai Hospital, Private Pavilion, on October 18, 1915, about a year and a half ago. The case has been fully reported in the ANNALS OF SURGERY, July, 1916. The incision here was in the seventh interspace, but here a long piece of the eighth rib was removed with its periosteum in order to gain space for the rib spreader and also the seventh and sixth ribs were divided posteriorly for the same reason. A large piece of the middle lobe and part of the lower lobe were removed with the aid of chain ligatures of chromicized catgut, section being made close to the hilum and about one-third of the middle lobe being removed. In this case there were numerous adhesions of the upper lobe to the chest wall which were not disturbed. A considerable abscess cavity lay between the upper part of the bronchiectasis in the middle lobe and the lower part of the upper lobe. Following the operation there was an immediate cessation of cough and expectoration. During convalescence there were, as in the second case shown, a few slight hæmoptyses. Now she is perfectly well, with function of chest and arms completely restored. The only deformity is that of the large cicatrix, where there is some contraction on account of the removal of the rib.

This patient and the one preceding developed bronchial fistulæ when the ligature of the stump came away. Both fistulæ closed spontaneously.

The principal reason for demonstrating these patients was to show the restoration of function and the beautiful symmetry following this operation when performed without multiple rib resection.

EXPLORATION OF THORAX IN EMPYEMA

A fourth patient was presented to illustrate the importance of complete exploration of the thorax in certain cases of empyema. The patient, a woman, twenty-eight years old, had fallen into the water and had been rescued in a nearly drowned condition. She must have aspirated a considerable quantity of water. About a week afterward she became very ill, and the case was finally diagnosticated as empyema, and an operation of the usual rib resection and drainage type was performed by another surgeon. It was said that a large quantity of pus had been evacuated. However, she continued to be very ill, being in a typhoid state, cyanotic, and weak, and the temperature rising as high as 104°. She was then referred to Dr. Lilienthal by Dr. William S. Thomas, and entered his service at Mt. Sinai

Hospital. There, on examination, he found a good-sized drainage tube in the patient's left chest through a rib resection opening in the posterior axillary line in the seventh space. Realizing that there was little to lose and that a complete exploration might disclose some unrelieved condition, he decided to operate.

Operation in gas and oxygen anæsthesia on October 4, 1916. Long intercostal incision with retraction by rib spreader. The pus within the chest was rather thin and yellowish in color. The tube drained the main cavity of the thorax, but there was a massive adhesion of the outer part of the lower lobe posteriorly, and when this was broken down a cavity containing about five ounces of thick green pus, quite different in character from that in the general cavity, was entered. On careful sponging and perfect exposure a small opening into the lung was found. The cavity was packed and the tube removed from the general thoracic cavity, no tube being employed for drainage. Another piece of the seventh rib posterior to the original section was now removed for purposes of drainage and the greater part of the wound was closed by suture. For a long time the patient was septic and for several days delirious. Gradually, however, things cleared up and she was discharged on January 11, 1917, well, except for an extremely minute bronchial fistula not large enough to warrant her wearing a surgical dressing of any kind. She has returned to her work.

RESECTION OF THE CHEST WALL FOR SARCOMA

Dr. Lilienthal presented a girl, nineteen years old, who was admitted to Mt. Sinai Hospital on October 31, 1916. Her illness had begun about six months before her admission. After a thorough study in the case, Dr. Brill, in whose service she was, transferred her to the surgical service. Six months before admission she developed pain and tenderness in the right chest. The pain was worse on deep inspiration. It disappeared for a few days and then recurred about twice a week until six weeks before admission, when it became very intense. There were no chills, no fever, no night sweats, no cough, and no expectoration nor hæmoptysis. Physical examination showed dulness in the right chest posteriorly below the angle of the scapula. The blood showed 24,000 white blood-cells, 88 per cent. polymorphonuclears, 8 per cent. small lymphocytes, 3 per cent. eosinophiles, transitionals 1 per cent. On admission the temperature was normal. Pulse and respiration also normal. The X-ray showed a circumscribed tumor in the posterior chest wall, involving the sixth and seventh ribs, the seventh being rarefied and apparently fractured. The shadow was globular in shape. Von Pirquet examination negative.

On November 6, 1916, in ether anæsthesia, an incision was made in the posterior part of the chest in the seventh interspace, opening into a free and apparently normal pleural cavity. The finger passed into the chest showed a rounded lobulated tumor projecting inward and not involving the lung. Sections of the sixth and seventh ribs were now removed with the periosteum and intercostal muscles, the anterior section being made in the

midaxillary line and posterior section behind the angles of the ribs. The two resected pieces of ribs were removed, and with them the tumor and all such soft parts as were adjacent, the pleura, intercostal muscles, etc. The lungs appeared perfectly normal. So far the operation had been performed under ether administered by the ordinary method, but now when it became necessary to distend the lungs previous to closure of the wound the operator was glad to have the assistance of Dr. Ware, who performed intrapharyngeal insufflation with a foot bellows, distending the lungs perfectly, the anæsthesia up to this time having been administered by a member of the house staff. The external muscles of the chest were now approximated with chromic catgut sutures and the skin was closed without drainage by interrupted and continuous silk sutures. Before the chest was closed by the last suture Dr. Ware inflated the lung so as to exclude intrapleural air. The patient stood the operation well, but there was a period of anxiety because of a post-operative psychosis which developed and continued for about a week. The diagnosis in this case, made by Dr. Mandlebaum, Director of the Pathological Laboratory, was " round-cell sarcoma."

This patient received a few injections of Coley's toxins post-operative, and was also treated by deep X-ray therapy. A few external applications of radium were also made by Dr. Bissell, the patient's family being anxious to omit nothing which might contribute to the permanency of her cure.

The patient has thus far remained free from recurrence and is able to attend to her occupation, that of dress model.

Dr. Charles N. Dowd said that the cases of lobectomy which Dr. Lilienthal had shown form a very important group. One very remarkable element should be noted, the mobility of the chest wall. It is much greater than in patients who have had extensive rib resections.

He inquired of Dr. Lilienthal whether old cases of empyema could be cured by cutting between the ribs.

Dr. Lilienthal replied that in old empyema with sinus it has been his practice to make an intercostal incision large enough to admit the rib-spreading retractor, and if, because of the rigidity so frequent in these cases, good exposure is not possible, he did not hesitate to divide one or more ribs upward or downward from the posterior angle of the wound until the rib-spreader can be effectively used. After then mobilizing the lung the parts may be permitted to drop back to their former position and the disadvantages of the various caving-in-thoracoplasties are avoided.

As to the size of the piece of lung removed in the case of the third patient, he would say that *in situ* the part was about the size of a small adult fist. A considerable collapse takes place, however, when the resected lung is removed from the body.

As to his mortality, he should say that it was in the neighborhood of 60 per cent., but he had not tabulated his cases for some time. The operation should only be performed in such cases as are considered not only incurable by other means, but in which it is pretty clear that without operation a fatal outcome is certain. His excuses for losing patients were varied.

Some have been badly selected and were not suitable for this kind of surgery. Others have died of pneumonia. One patient, a child, in which he had resected the upper and lower lobes of the right lung, was doing well five days after operation and it unfortunately fell out of bed and died a few hours later, probably due to the tearing loose of the steadying suture and the occurrence of mediastinal flapping. Unfortunately no autopsy was permitted. When it is realized that only about one-third of these patients who are operated upon by merely palliative procedures are saved, an equivalent percentage of recoveries, *with complete restoration to health,* is, after all, an advance. Dr. Samuel Robinson advises dividing the operation in two or more stages and performing rib resection with the consequent caving in of the thorax. It may be that some method between the one which that surgeon employs and that which he had reported may turn out to be the method of choice.

INGUINAL HERNIOTOMY UNDER NOVOCAINE ON THE SEVENTH DAY POST PARTUM

Dr. Seth M. Milliken presented a woman, aged twenty-eight, who, in March, 1916, was found to have a right indirect inguinal hernia.

As she was then six months pregnant, she was advised to be careful and to have an operation after the delivery. She was normally delivered June 12, 1916. Puerperium perfectly satisfactory. Seven days later the operation under 5-10 per cent. novocaine with adrenalin was done.

A glovefinger-like congenital sac was easily removed and the canal closed *in toto*. The time from the first injection to the last stitch was forty minutes.

The nursing of her baby was uninterrupted and the skin sutures were removed on the fifth and seventh days.

She was treated as a normal obstetric case after the fifth day postoperative; that is, she was allowed to sit up in bed on the fourteenth day of puerperium and was allowed out at the end of four weeks.

It seems well worth while to use this method in such cases, for in this case the hernia operation was hardly more than a momentary inconvenience in the course of her obstetric recovery.

SUBACROMIAL BURSITIS

Dr. Frederic Kammerer presented an adult woman, who, during the summer of 1915, slipped while walking and with considerable difficulty prevented a fall. For six weeks following the accident she had constant, moderate pain over the right shoulder, but she was able to follow her profession as a trained nurse. At the end of this time she woke up one morning with severe pain in the anterior portion of the shoulder-joint, which grew worse, until it entirely incapacitated her. Three days later an X-ray picture was taken which showed a distinct calcareous deposit over the greater tuberosity. Pain and disability became more pronounced. An incision was made through the deltoid muscle about a week later. On incising the outer

wall of the bursa the calcareous deposit beneath its inner wall was neatly exposed, projecting into the lumen of the bursa. A circular band of adhesions around the latter was readily separated with the finger, and the bursa was then opened wide. After cutting through its inner wall the semi-fluid, whitish deposit was exposed and removed. In part it lay between some fibres and the supraspinatus tendon. The individual layers were now closed with sutures and the arm fixed in abduction for a week. Massage, passive and active movements, continued for three weeks more, fully restored the usefulness of the limb.

Dr. John Rogers said that such bursal inflammations are probably much more common than is generally believed. They frequently pass under the diagnosis of "rheumatism," and consequently have the same outcome or spontaneous recovery.

A number of years ago he attended a rather nervous woman who had a typical case of this condition, including the calcareous deposit shown in the radiograph. The pain persisted for a couple of months and then gradually subsided. She refused operation, and finally, without any treatment made a perfect recovery.

Dr. James Hitzrot agreed with what Dr. Rogers had said about the frequency of this lesion. It is quite common and is especially common in baseball players. The symptoms are intermittent in character. Any strain upon the external rotator tendon will, however, bring back the symptoms, and an individual with this calcareous change in the tendon will have trouble in getting the arm over the head and especially in movements requiring rotation at the shoulder-joint.

To call the lesion a subacromial bursitis is a misnomer. The lesion lies in the tendon of the supraspinatus muscle beneath the posterior wall of the bursa or in the bone in those cases in which a fragment of bone has been torn loose; and one has to go through the posterior wall of the bursa to reach the real lesion.

Operation is indicated in the severe cases and apparently relieves the condition. In isolated cases after operation the same motions which caused the pain before operation will be painful, and an X-ray at this period will show no deposits in the tendon.

Dr. H. H. Lyle said that he wished to emphasize the point that the presence of a calcareous deposit does not necessarily indicate operation. Such calcareous deposits often disappear under conservative treatment. He had the privilege of seeing a case of double calcareous deposits following trauma. After trauma to the right shoulder a subdeltoid bursitis arose. A radiograph showed a calcareous deposit in the bursa. The patient was treated by conservative means, and the bursitis and the calcareous deposit disappeared entirely. Strange to say, the patient developed a similar condition in the left bursa. This was treated in a similar manner and the same results obtained.

Attention has been called to this condition by Dr. Hoffmeister, of Germany; Dr. Berry, of Albany, and Dr. Morris K. Smith, of New York.

DR. HOWARD LILIENTHAL said that for about thirteen years he himself suffered from all the symptoms of so-called subacromial bursitis of the left shoulder. Finally, when the trouble began in the right shoulder and the disability became truly serious, he was treated by scientific massage with the happy result of perfect restoration of function. Since then he had seen a number of these cases. He had operated in only one, and, although the patient was temporarily relieved, there was a recurrence of symptoms later on. In his own case no X-ray was made, so he was not sure whether or not there was lime deposit. In another patient, however, in which there was great pain and disability and in which, as in his own case, heat, medicines, and other remedies had failed, a cure was also effected by massage. He had seen perhaps six of these cases exclusive of the man upon whom he operated and all were relieved by massage. It appeared to him that operation should indeed be the dernier resort in the therapy of subacromial bursitis.

DR. ALEXIS MOSCHCOWITZ said that his associate, Dr. Brickner, had paid a great deal of attention to cases of subdeltoid bursitis, and, as a matter of fact, all cases are more or less turned over to him at the present time for treatment and operation also.

He had seen a number of these cases. He had watched particularly operations by Dr. Brickner and all of these cases have shown calcareous deposits in or about the tendon of the supraspinatus. These cases have been examined pathologically by Dr. Eli Moschcowitz; sections have been made and examined very carefully and it can be shown that the calcareous deposit has been in the tendon.

DR. WILLIAM DARRACH disagreed with Dr. Hitzrot's statement that the calcareous deposits always lay beneath the deeper layer of the bursa. He had cut down on one in which the calcareous deposit was between the muscle and the superficial layer of the bursa. He thought there are two distinct classes here, one the acute bursitis and the other the tearing fractures of the greater tuberosity lifting up a projecting fragment of bone, which is the cause of the irritation of the bursa.

Certain of the X-ray pictures in these cases show a very distinct tearing off of a little elevation from the tip of the greater tuberosity. He had cut down on two cases where, as the bursa was opened, could be seen projecting forward a sharp spicule of bone due to the lifting off by the supraspinatus tendon of a portion of this greater tuberosity, leaving a sharp spicule there which extends almost through the deeper layer of the bursa. These form one distinct group in which one can get a traumatic history.

In some of the other cases without a distinct traumatic history, the condition is more likely to be a true bursitis. The majority of the cases will subside after a certain length of time, anywhere from three to six months, if they are massaged or if they have the proper form of motions after the acute symptoms have been allowed to subside with rest. Rest until the acute symptoms have subsided and then proper massage and motions will cure a great many of them, but there are a great number in which the acute symptoms persist or recur in spite of everything.

In one case operated upon by him last summer the acute symptoms had persisted for a year. The woman was almost unfit for work and frequently had no sleep at all. The most marked case he had ever seen as far as the calcareous deposits go was a man who had a very large calcareous deposit which on X-ray seemed to be a centimetre in thickness. He advised him strongly to have an operation, which he agreed to, as soon as he got back from abroad. He was held up on the other side longer than he expected and when he got back his shoulder was better and one year later he was able to play a very good game of golf and he has not been operated on and has no symptoms at the end of two years. An X-ray has not been taken recently.

HYPERTHYROID GOITRE WITH PNEUMOCOCCUS ABSCESS

Dr. Clarence A. McWilliams presented a woman, K. B., fifty years of age, who had had four children and four or five miscarriages, and who came into the Presbyterian Hospital in July, 1916, complaining of swelling in front of neck, nervousness, palpitation of the heart and loss of strength. She did her own housework for a family of seven. Her mother had a goitre for over fifty years and a sister has had a goitre for several years. The patient is a native of New York City and has always lived here except for four years in New Jersey. Thirty years ago, after the first child was born, she noticed a fulness in the front of the neck just above the sternum, which caused no trouble whatsoever. It seemed to grow a little with each confinement. Seven months ago patient had a severe sore throat, following which the goitre became enlarged, swollen, tender and painful, and for which ice-bags were applied. The pain disappeared but the swelling persisted. During the past seven months the patient has had four attacks of tenderness of the right side of the goitre, lasting about a week each. The present attack of tenderness and increased swelling began about two weeks ago and both have persisted since. For a number of months she has tired very easily, she has palpitation and she feels her heart flutter. She is much more nervous than formerly and is easily excited. She perspires much more, her hands are unsteady. Her weight decreased from 165 pounds to 130. For the past four months she has been receiving X-ray treatments at Mt. Sinai Hospital without any benefit. There was no history of dyspnœa nor obstruction to breathing, diarrhœa nor chills. Examination shows marked enlargement of the right lobe of the thyroid. This is very tender, firm and nodular and hard. Isthmus also enlarged. Left lobe not enlarged. There is no pulsation nor bruit over the left lobe. Pulse averaged about 110, was regular with no murmurs. The blood-pressure was systolic, 168, diastolic, 90. The blood count was 6600 and polymorphonuclears 53 per cent. X-ray picture of the chest showed no enlargement of the thymus nor did the goitre extend down below the upper extremity of the sternum. The successive attacks of pain, swelling and tenderness in the hyperthyroid goitre were explained

on the basis that successive hemorrhages had taken place in the goitre at various times. The temperature for five days prior to operation averaged 100.5° and the pulse 110.

On July 26, 1916, a right hemithyroidectomy with excision of a nodule in the isthmus was performed under nitrous oxide and oxygen anæsthesia preceded by a hyoscine and morphine hypodermic injection. No ether was used. The external fibrous capsule was most adherent to the whole gland, particularly above and posteriorly. After splitting the capsule vertically in front, with great difficulty the right lobe was shelled out with the finger. This adherence was erroneously supposed to be due to the previous influence of the X-rays, since no pus was encountered during the operation at any time. There was a prolongation of the upper pole which extended behind the trachea. This was worked out with difficulty with the finger, owing to its adherence. The lobe was hard, suggesting carcinoma, and nodular and was probably four times its natural size. The hemorrhage was not troublesome. A nodule, size of a walnut, was removed from the isthmus, and the right lobe was removed. The left lobe seemed fairly normal, so it was left. A goitre drainage tube was placed in the cavity left on the right side. The operation lasted fifty minutes. The patient was in good condition, though the pulse was 160, requiring no stimulation.

On sectioning the lobe immediately after the operation an abscess cavity $3 \times 2 \times 2$ cm. was opened, containing about a drachm of thick, light brownish, odorless pus. Culture from this gave pneumococcus group IV. The infection of the lobe was probably responsible for the adhesion of its capsule rather than the X-rays.

Pathological Examination.—Gross Specimen: There are 2 specimens. (1) The right lobe of the thyroid tissue, $4 \times 2 \times 2$ cm. Cross-section of right lobe shows an interesting condition. In the anterior surface is what appears to be a broken-down area of tissue forming a cavity $3 \times 2 \times 2$ cm. The wall of this cavity appears to be made up of thyroid tissue and scattered through the tissue immediately adjacent to it appears to be a material similar to that seen in a hypernephroma. Scattered through the cut-surface of the lobe, the tissue varies a great deal in appearance, markedly colloid in places, in others apparently adenomatous.

Microscopic Examination: The microscopical picture varies considerably in the different parts of the gland. Sections from the nodular masses in the thyroid show a picture of adenomatous hyperplasia which in place approaches a carcinomatous type. But from a mere pathological examination, it is believed impossible to make an absolute diagnosis. It may or may not be malignant. Only the follow-up notes, three to five years from now, will answer the question. Inasmuch as all of the lobe on the right side and the isthmus has been removed, and inasmuch as sections from the isthmus show nothing more than adenoma, further operative procedure is not advised. Sections from wall of abscess show a rather chronic inflammatory process. There were a great many round-cells as well as polynuclears. There are also a few giant-cells, but they are not grouped typically, nor are there other evidences of tuberculosis.

Diagnosis.—Adenoma of thyroid. Abscess of thyroid (Pneumococcus, group IV).

After Result.—On the second day after the operation the patient had severe pain in the left cheek and over left mastoid. The left parotid became swollen and exquisitely tender. There was only a degree elevation of temperature and the leucocytes were 8000. Diagnosis of parotitis was made which finally subsided without incision under the use of ice-bags.

Result after five months: The patient has improved very much. She has gained weight. She sleeps and eats well, is not nervous nor tremulous. Her heart does not flutter, though it averages 100. She has her full strength and vigor. The left lobe of the thyroid has increased in size and is now distinctly palpable. With any recurrence of the symptoms of hyperthyroidism removal of half the left lobe would be in order.

Patients with suppuration of the thyroid gland are comparatively rare. Only three cases of suppuration in the thyroid gland have occurred in the Presbyterian Hospital, in only one of whom was the suppuration associated with goitre. The second case was a woman of twenty-three who had had a swelling and pain for a week in right lobe of thyroid. Highest temperature 100° with leucocytes 18,000 and polymorphonuclears of 8470. Six ounces of thick, yellowish pus were evacuated from the right lobe. Cultures were sterile. Recovery. The third case was a man of thirty-two who had been treated for syphilis and had a 4+ Wassermann. Four days prior to his admission he was seized with stabbing pain in left side of neck. Noticed no swelling in neck. On palpation there was deep induration over the left lobe of the thyroid. His temperature was 104°, leucocytes 14,000 and polymorphonuclears 80 per cent. At operation the thyroid capsule was œdematous and in the left lobe there was an abscess containing one and one-half drachms of very foul pus, fetid, such as occurs in the mouth and teeth. Recovery. Culture showed streptococci hæmolytica.

ACTINOMYCOSIS OF PHALANX OF FINGER

Dr. Clarence A. McWilliams presented a man twenty years of age, whose chief complaint was of pain in the bone of the first phalanx of third left finger. Six months previously he cut the knuckle of that finger on an adversary's tooth. He came to the Presbyterian Hospital Dispensary twice and the cut healed in four days. Two or three weeks later finger began to swell at site of injury. This swelling increased slowly. One month ago began to have pain in swelling. No pain in hand or arm. The pain was dull aching. The function is gradually lessening. Swelling broke down about a month ago, discharging a few drops of pus. This closed again in three days. It is now red and tender. No other points in history have any bearing.

Examination shows that the left hand feels and appears normal in every way except for the third left finger, on both sides of the proximal phalanx of which is a fusiform swelling, slightly bluish colored and tense and brawny with a small scar of the old sinus which is now healed. It does not fluctuate, is only slightly tender. It is attached to the deeper structures

and limits motions of finger only by its size and position. The X-ray (Fig. 6) diagnosis was bone cyst of proximal phalanx of the left middle finger. The sinus had closed, so there was no discharge which could be examined. Wassermann negative. Incisions were made on each side of the finger. The soft tissues were evidently changed from the normal, being dirty gray in color and more fibrous than normal tissues, not broken down. No pus was found. A section was taken for frozen examination. The report was sarcoma, so amputation was performed at the metacarpophalangeal articulation. The tendons and sheaths were not involved.

Pathological Examination.—Gross specimen: Specimen is a middle finger disarticulated at the metacarpophalangeal joint. On either side of the proximal phalanx are incisions down to the bone. On cross section through the middle of the proximal phalanx, the cortex of the bone is exceedingly dense and about 4 mm. in thickness. The lateral aspect of the bone has been exposed by the operative incision and is very much eroded. The mesial aspect of the bone is likewise eroded, but not to as great an extent. The tumor does not seem to be at all adherent to the eroded portions of the bone, thus showing that it is pressure erosion rather than a destructive bone tumor. The tumor has no definite outlines but appears to extend the entire length of the proximal phalanx on both lateral aspects. The two masses do not appear to connect with one another. The tendons and tendon sheaths appear intact.

Microscopic Examination: Sections from the soft parts of the finger over the proximal phalanx show at several points large collections of round and polynuclear cells forming practically small abscesses. In the middle of one of these is a ring-like body about the size of a pin-head which is amorphous and stains a very deep blue on the inside of the ring, while on the outer side are innumerable closely placed short rods, the ray fungi, which stain red. The spaces between the connective tissue are infiltrated with solid cords of round cells. Section of the phalanx shows very dense cortical bone which is ragged at the edges, showing erosion. At one point in the cortex some trabeculæ of new-formed bone are growing out into the surrounding connective tissue. There is no sign of the ray fungus in or about the bone.

Diagnosis.—Actinomycosis of dorsal and volar surface of finger.

There is but one other case of actinomycosis in the records of the Presbyterian Hospital. This was in the postanal region. The region was excised six years ago. There was a recurrence in three years with a second thorough excision. That was three years ago and up to the present there has been no recurrence.

LATE RESULT OF PARTIAL EXCISION OF STOMACH FOR CARCINOMA

Dr. Frederic Kammerer showed a patient, whom he had already presented to the Society, once in November, 1900, a few months after operation, and again in December, 1902. The operation, which was done for a carcinoma of the stomach, consisted in the removal of the pylorus, the entire lesser curvature and more than half of the stomach. A Murphy button was employed in reëstablishing continuity of the intestinal tract. The speaker stated he had no other cases of resection of the stomach alive five years

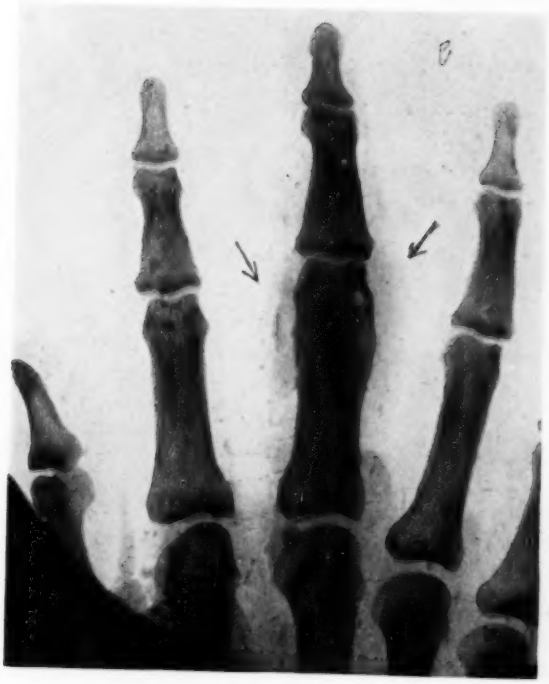

FIG. 6.—Actinomycotic tumor of phalanx.

after operation, and he had, from time to time, seen most of them, unfortunately with recurrences. The greater number had died about two years after operation, some of them had lived for three or four years. Küttner, who has lately published his results, found 18 per cent. of his patients alive from three to seven years after resection of the stomach for cancer. He mentions one case operated on by Kausch, living and well eleven years after resection of three-quarters of the stomach. The patient shown has no recurrence after sixteen years, and he may, therefore, be considered a permanent cure, again demonstrating the fact that the large, palpable tumors are not always the inoperable ones.

NON-FUNCTIONATING PYLORUS FOLLOWING GASTRO-ENTEROSTOMY WITHOUT PYLORIC OCCLUSION

Dr. Burton J. Lee presented a man, fifty-two years of age, who was admitted to New York Hospital, in the service of Dr. Charles L. Gibson, two years previously. There had been a history of ulcer of the stomach extending over fourteen years. During the preceding two years the symptoms had been greatly aggravated, with frequent vomiting, associated with gastric pain. Upon admission, patient showed extreme emaciation, with marked general weakness. There was tenderness in the upper abdomen, with indefinite signs of a mass in that region. Preoperative diagnosis lay between neoplasm and ulcer.

Exploratory operation revealed a large mass occupying the pylorus and extending into the lesser omentum, along the lesser curvature. Several nodes which were quite evident upon the greater curvature were removed for microscopical examination. A posterior no-loop gastrojejunostomy was performed, three layers behind and two in front. Pathological examination of the nodes revealed no evidence of malignancy. The man's recovery was normal and he has had a gain in weight of upwards of thirty pounds.

X-ray plates showed the gastro-enterostomy working, with the stomach nearly empty in five hours. Nothing was apparently passing through the pylorus.

The case was presented to bring up for consideration by the Society the wisdom or unwisdom of occluding the pylorus in such cases.

VICIOUS CIRCLE FOLLOWING POSTERIOR NO-LOOP GASTRO-JEJUNOSTOMY FOR DUODENAL ULCER, RELIEVED BY ENTERO-ENTEROSTOMY

Dr. Burton J. Lee presented a man thirty years of age, who was admitted to New York Hospital, November 4, 1916. There had been a history of six years of digestive distress, characterized by pain in the epigastrium, usually relieved by the induction of vomiting. There had never been any blood in the vomitus. The man's symptoms had been very much aggravated during the past two years.

Operation was performed November 4, 1916. A markedly indurated duodenal ulcer was found, just distal to the pyloric vein, apparently involving the posterior wall. A posterior no-loop gastro-jejunostomy was done, three layers behind and two in front. During the first post-operative week recovery seemed satisfactory. Then patient vomited eleven ounces of yellowish fluid and an hour later thirteen ounces of brownish fluid. Lavage was instituted over a period of several days, with relief of the symptoms, but several days later there was a repetition of the vomiting with considerable epigastric distention and distress. On the third of December, about one month following the original procedure, lavage brought away 1900 c.c. of turbid, bile-stained fluid, and the following day 2000 c.c. of greenish fluid was removed in a similar manner. Tests for blood were positive in both these fluids. Patient's general condition was steadily growing worse, with marked emaciation and pallor.

Operation was performed under gas and oxygen anæsthesia. It was found that the jejunum had become adherent to the area of ulceration, making a sharp bend in the gut at this point and causing a definite obstruction, which accounted for the vicious circle established. An entero-enterostomy between the two loops of the jejunum was performed, three layers behind and two in front. Convalescence from that time on was uneventful. The man was given fluid by infusion, hypodermoclysis and by rectum. Five days later he began to eat solid food without discomfort.

The man's general condition is now excellent and his gain in weight has been upwards of twenty-five pounds. X-ray examination by Dr. Busby a week ago showed stomach nearly emptied in three hours, a small amount of barium passing through the pylorus. The man at present has no complaints.

This case is called to the attention of the Society to bring up the question of the frequency of the occurrence of a vicious circle following a gastro-enterostomy and to point out one factor in the causation of the condition.

AVULSION OF TENDONS OF THE LEFT FOREARM, FASCIA FLAP INSERT TO OVERCOME TENDON DEFECT

Dr. Burton J. Lee presented a man thirty-eight years of age who was admitted to New York Hospital October 13, 1916, in the service of Dr. Charles L. Gibson. Just before admission his left forearm had been caught in a cutting and rolling machine with avulsion of considerable skin, muscles and tendons from the arm. The man was in a condition of moderate shock and was taken immediately to the operating room, where, under a general anæsthetic, the wound was opened and explored. There was a ragged, lacerated, badly soiled wound on the back of the left forearm (Figs. 7 and 8). A portion of the first and second extensor tendons was intact. Other tendons were missing. It was impossible by any plastic procedure to bring the tendons into contact with the muscles. An aponeurotic flap was there-

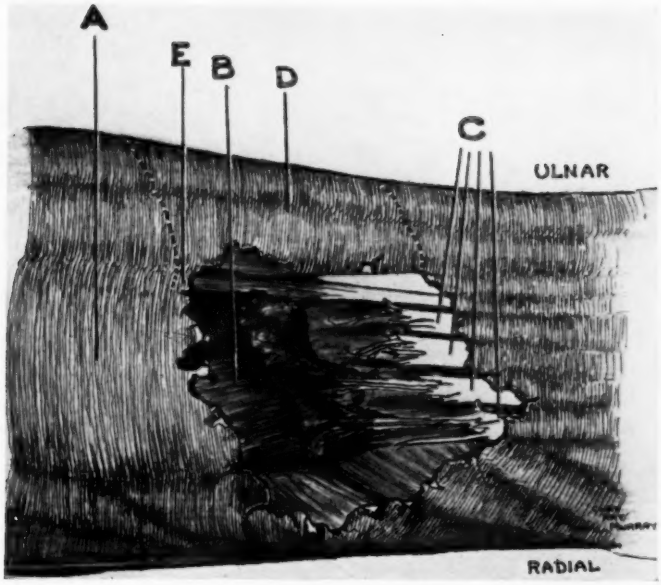

FIG. 8.—A, deep fascia of arm; B, torn belly of flexor muscle; C, torn tendons of flexor muscle D, dotted lines indicate fascial flap; E, pedicle left for nutrition of flap.

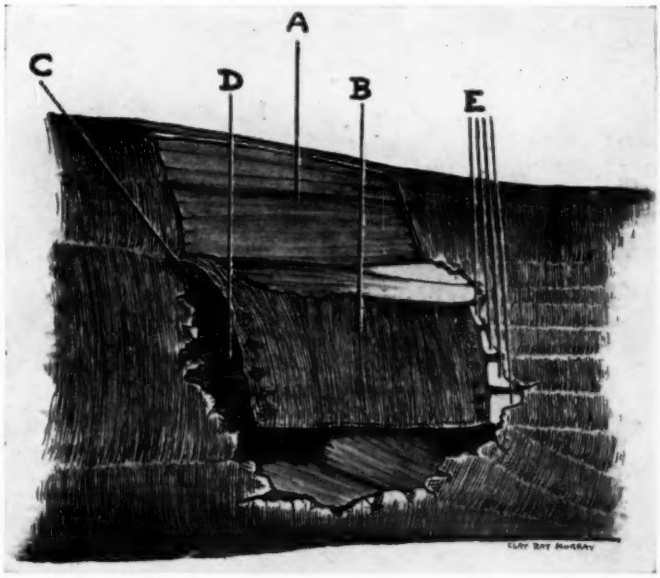

FIG. 9.—A, area denuded in formation of flap; B, flap turned down on C, pedicle, and sutured to D, flexor muscle belly, above, and E, flexor tendons, below.

fore dissected up from the ulnar side of the forearm, leaving a small pedicle at its upper mesial aspect, the flap being rotated upon itself and made to lie between the muscles and the tendon ends, being sutured above to the muscles and below to the tendons, with interrupted chromic gut sutures (Fig 9). The wound was closed in such a manner that the aponeurotic flap was protected by skin covering. Several small rubber dam drains were placed through openings in the sutured skin wound.

It was believed that the man would very probably lose the function of his extensor communis digitorum from sloughing and suppuration. It was felt possible, however, that the aponeurotic bridge might become effective as tendon and muscle.

The extremity was kept immobilized for six weeks and then passive movements and later active movements were begun, for both wrist and fingers.

The man has now been at work for the past two weeks and can extend his wrist and fingers to a line parallel with the forearm, but no farther. The extensor group is not quite as strong as on the other side and the

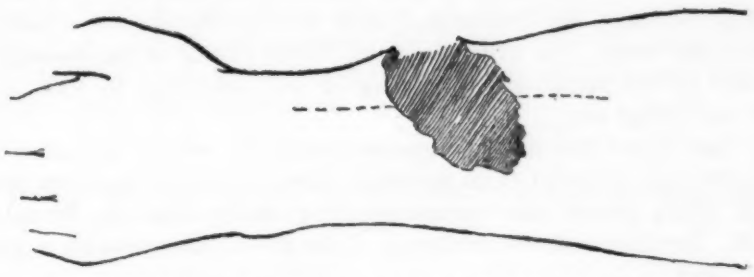

FIG. 7.—To denote site of injury to forearm, size of area involved and line of skin incision (dotted line

inability to completely extend is due to the fact that the fascial flap is a little longer than necessary, preventing full extension power. However, he has a perfectly usable and useful hand. He has, in addition, independent movement for the various fingers. The fairly useful arm which he presents illustrates the possibility of using the aponeurotic flap insert for cases with similar tendon defect.

DUODENAL ULCER CURED BY GASTRO-ENTEROSTOMY: RECURRENCE OF SYMPTOMS DUE TO NONABSORBABLE SUTURE, DANGLING FROM THE STOMA, AND CURED BY ITS REMOVAL

DR. GEORGE WOOLSEY presented a woman operated on by him in 1913 for a duodenal ulcer, doing a gastro-enterostomy in the usual way. She made a good recovery except that she had an unusual complication, a suppurative parotitis. She was well after that for about a year and eight or nine months, then the gastric symptoms returned and in spite of medical treatment, rest and diet in spite of all that could be done for her, she got no better.

Two X-ray series did not give any very definite information. On opening the abdomen, just two years almost to the day after the first operation, there was nothing abnormal, externally, at the site of the gastro-enterostomy. There was no induration and no adhesions.

The ulcer had apparently healed, so he made an incision into the stomach, and there, hanging from the inner surface of the stoma, was about three inches of black thread. He pulled on this and pulled out three or four inches more. At the point where the thread was pulled out there was no ulcer. He looked for an ulcer in the jejunum beyond this and over the adjacent surface of the stomach, and there was no ulcer to be found; so he sewed up the stomach and the patient made a good recovery and has been well ever since. This was in October, 1915. She is a nurse and has had some tuberculous pleuritic trouble, but in spite of this she was able to get along very well.

Such a case shows the danger of the use of a non-absorbable suture. Since that day he had not used any non-absorbable suture in gastro-enterostomy. No. 0 chromic catgut is quite sufficient for both layers of sutures. In the second place, the symptoms of ulcer were produced here without any demonstrable ulcer. The irritation of this thread pulling on the stomach was the cause of her symptoms, for the relief was immediate as soon as the thread was pulled out.

He had seen a few cases of gastro-enterostomy which, perhaps not as late as this, but earlier after an operation, showed signs of recurrent gastric trouble, which passed away spontaneously, probably after the thread was cast off. In other cases the irritation of the thread may produce a gastro-jejunal ulcer.

Dr. John Rogers remarked that there seems to be a well-founded objection to the use of linen or non-absorbable suture material in gastro-intestinal anastomosis. Yet the outer or serous layer of sutures is generally made with linen. Experiments, first performed by Senn, have demonstrated that all non-absorbable suture material of the gastro-intestinal tract is ultimately passed into the lumen of the gut. Hence, if linen sutures of the mucosa layers of a gastro-enterostomy are not advisable, linen sutures of the serosa and muscularis should be equally objectionable. The fact that Dr. Woolsey's case was immediately relieved by removal of the thread is another experiment to prove the advantages, for suture material, of chromicized catgut.

Dr. Eugene H. Pool said, in regard to employing a continuous non-absorbable suture in gastro-enterostomy, he had come to the conclusion that it is to be avoided both from experiences in two cases which he had seen himself and from similar experiences which others have reported. In his two cases, posterior gastro-enterostomy was performed; a linen continuous suture was used for the outer layer and a fine chromic for the inner. Symptoms of ulcer developed a few weeks after each operation. The symptoms persisted, and about six months after the respective gastro-enterostomy the abdomen was reopened. In each case an ulcer was found about a centi-

metre and a half in diameter on the jejunal side of the gastro-enterostomy opening, and in each case part of the non-absorbable linen thread could be seen at the bottom of the ulcer. In one case the knot lay on the floor of the ulcer. There was no question in those two cases that the non-absorbable material had influenced the development of the ulcers. In each case the ulcer was rather chronic looking in that the edges were very firm and raised and the floor likewise indurated, as if the ulcer had been there for a comparatively long time.

If interrupted linen stitch had been used, of course a stitch would have been cast off before an ulcer became chronic, and the chances are that a recent ulcer would have healed; but a continuous linen stitch must remain for a long period embedded in the tissues, and the exposed portion acts as a constant irritant.

He has given up entirely using a non-absorbable continuous suture for either row. He uses occasionally a few linen interrupted sutures external to the outer layer of chromic catgut.

Dr. Charles N. Dowd said that for a year and a half he had used interrupted Pagenstecher (linen) sutures for the outer row, thus avoiding the danger of long-hanging sutures. He thought this did not add more than three or four minutes to the time of the operation, and that the advantages more than compensated for this time.

CHRONIC GASTRIC ULCER: RESECTION: GASTROJEJUNOSTOMY (POLYA-REICHEL)

Dr. Woolsey presented a woman, sixty-six years old, who has had more or less indigestion for a number of years. For three years previous to last December she had periodic attacks of gnawing pain in the epigastrium, relieved by milk diet for a few days. The attacks were infrequent and in the intervals she was comfortable, but had to avoid fruit and raw vegetables.

At the end of September she had an attack of epigastric pain coming on about an hour after eating, lasting until the next meal and relieved for a time by eating. She never vomited spontaneously, but often induced vomiting to relieve the pain, and she was often nauseated. During this attack, which lasted until December, she lost twenty pounds. Two X-ray series, taken previously, showed a six-hour residue and a pyloric defect. The diagnosis was gastric ulcer. After the second X-ray series she had a very severe attack of bismuth poisoning. A test-meal showed hypersecretion and hyperacidity. Medical treatment, with Lenhartz diet and rest in bed for two months or so, gave no relief.

Midway between the ensiform and the umbilicus there was a palpable, tender mass, the size of a large egg, slightly movable. On operation December 7, 1916, there was found along the lesser curvature, just proximal to the pylorus, a marked induration, with a nodular hard projection, sug-

gestive of new growth. The pyloric region was firmly adherent posteriorly and the retropyloric glands were enlarged and firm.

He resected the pyloric end of the stomach and sutured the proximal end directly into the jejunum by the Polya-Reichel method. She made a very satisfactory recovery. The pathological report was chronic ulcer, with no malignant degeneration.

One interesting point about this is that the test-meal, taken just before she left the hospital in January, showed a total acid of fifty-six and a free hydrochloric acid of fifty. All of the pyloric antrum was removed, showing that the removal of the pyloric end of the stomach does not affect the acid content in the gastric juice. She has gained considerably in weight and is very well.

PERFORATED GASTRIC ULCER: SUTURE WITHOUT GASTRO-ENTEROSTOMY: RECOVERY: RECURRENCE: GASTRO-ENTEROSTOMY: REPEATED SEVERE HEMORRHAGES FROM THE ULCER: TRANSFUSION: RECOVERY

Dr. Woolsey presented a man, thirty-seven years of age when admitted to the hospital on the first of November, 1915. He gave a history of having, seventeen months before, had a perforated gastric ulcer, which was sutured at Hudson Street Hospital, without gastro-enterostomy. Their report was a perforated ulcer, one and a half inches from the pylorus.

For the past five months he has had a feeling of heaviness, or a burning and sometimes a griping pain in the epigastrium, sometimes while eating, but most severe before meals, relieved or alleviated by eating. Vomiting often occurred about two hours after eating, and this relieved the pain. The vomitus sometimes was like coffee grounds. He had frequently noticed tarry stools. The symptoms had been nearly continuous. One hour after Ewald meal, 600 c.c. were expressed, which gave total acid seventy, free hydrochloric acid fifty, no blood. An X-ray series showed a persistent defect in the pyloric region, suggestive of ulcer.

On operation November 10, 1915, the pyloric end of the stomach was found adherent by bands to anterior abdominal wall and the lower edge and under surface of the liver. A small indurated scar a little proximal to the pylorus was taken to be the site of perforation. Posteriorly this region, and the first portion of the duodenum, were much indurated and very adherent to the indurated pancreas behind.

Owing to the inherent difficulties no resection was done, but a no-loop posterior gastro-jejunostomy was made with two rows of No. 0 chromic gut sutures, and the pyloric end relatively excluded, by infolding, by three rows of mattress sutures. On the fourth day after operation the patient had the symptoms of hemorrhage, vomited blood, and soon afterward passed tarry stools. Two days later he felt well and hungry, but weak. The hæmoglobin was fifty-five per cent., red corpuscles, 1,600,000.

The wound healed per primam. On the seventh day after the operation he again showed symptoms of hemorrhage and was treated, as before, by morphine, horse serum and hypodermocylsis. On the ninth day after operation hæmoglobin ten per cent., blood-pressure too low to count, and patient drowsy and scarcely conscious. He was transfused by Dr. Lindemann, by his method, receiving 1100 c.c. When he had received 480 c.c. consciousness returned and after 1100 c.c. he looked and felt like a new man. Immediately after this he was operated under general anæsthesia.

He had in mind a case presented before this Society by Dr. Downes that he had re-operated for hemorrhage within twenty-four hours of the operation and had found the bleeding point at the margin of the stoma. On going through the old wound and opening the stomach the gastro-enterostomy was found to admit two fingers easily—it might have admitted three. It appeared perfectly smooth and entirely healed. There was no bleeding point and no ulceration. The point of exclusion by infolding would not allow the passage of the finger, though it was not absolutely tight.

He was convinced that there was no hemorrhage from the site of the gastro-enterostomy, but to make doubly sure he made a continuous lock suture of chromic catgut around the opening.

The man made a fair recovery, although there was a little hemorrhage the next day, and he got quite restless. His pulse went up to 130 odd and he spit up a little fresh blood. The source of the hemorrhage here, he was very sure, was from the ulcer, not from the gastro-enterostomy. He had been bleeding before operation, as he had coffee-ground vomitus and tarry stools before operation.

Gastro-enterostomy is not a sure cure for hemorrhages from ulcer, neither is unilateral exclusion, as reported by V. Eiselsberg in at least one case where, after his operation of unilateral exclusion, hemorrhage continued.

He had a complication after this. The opening of the stomach was sutured without inverting, as he usually did, using the "loop on the mucosa" stitch; here he used a lock stitch without inverting, but everting, then buried that with a Lembert suture. The man got up a gastric fistula, so the wound broke down, and he now has quite a large hernia. The wound healed up spontaneously without further operation, and the patient has been otherwise well ever since.

This case is of interest for these reasons: In the first place, he had a perforated ulcer. He was cured of the immediate effects by a suture operation without gastro-enterostomy, but he had a recurrence of ulcer. The addition of gastro-enterostomy would probably have avoided this. In the second place, he had severe hemorrhage from the ulcer after gastro-enterostomy, and his life was saved by the direct transfusion of blood. The second operation revealed no bleeding from the gastro-enterostomy, and was therefore really unnecessary.

RELATION OF THE ILIOHYPOGASTRIC NERVE TO THE RADICAL CURE OF INGUINAL HERNIA

Dr. Alexis V. Moschcowitz read a paper with the above title, for which see page 79.

Dr. Charles N. Dowd remarked that it was interesting that a little piece of small nerve could occasion so much discussion. Possibly the amount of discussion is out of proportion to the importance of the subject. But at all events it is helping to clarify one's views of nerve anatomy and nerve physiology and the questions involved in the cure of hernia. The real question must not be befogged by a study of motor and sensory nerves. The real question is, Does the iliohypogastric nerve give off fibres with trophic function within the field of hernia operation? In hernia operations the external oblique aponeurosis is usually split for three inches, more or less, above the external abdominal ring. If the nerve gives off fibres within this area care should be taken to preserve these fibres. This illustration from Spalteholz (Fig. 10) may refresh our idea of the anatomy of the parts. It is seen that the lower fibres of the internal oblique muscle run almost transversely from Poupart's ligament to the aponeurosis which forms the sheath of the rectus abdominis muscle. These fibres may act independently of the remainder of the muscle, just as other fibres of the muscle may act independently.

This local action of portions of the abdominal muscles gives the localized rigidity which is so important in diagnosis. It is dependent upon the complex nerve supply. The internal oblique muscle is supplied by at least seven nerves—the lower five thoracic, the iliohypogastric, and the ilioinguinal. Hence, localized contraction of different parts of the muscle is obtained when needed. He had seen such contraction of the fibres about the internal abdominal ring under electrical stimulation during operation. Where are the nerve fibres which conduct this local stimulation? It would seem self-evident that they come from the nerve which traverses them.

This nerve, the iliohypogastric, traverses the entire breadth of the muscle from the lumbar fascia to the lowermost fibres at the internal ring. It lies, at first, at the under surface of the muscle, then passes obliquely through the muscle fibres, and then lies upon the outer surface of the muscle. According to his view, it gives off small filaments to the muscle fibres throughout this course until it has supplied the filaments to the innermost muscle bundles at the internal abdominal ring. If this is true it certainly should be protected at the locality where these filaments are given off. His reasons for believing this anatomical arrangement are as follows:

1. It is the natural arrangement and corresponds to the nerve supply in other parts of the body.

2. Anatomists describe such an arrangement. For example: Spalteholz says that "during its entire course between the broad and the straight muscles of the abdomen it gives off rami musculares to them." Morris says, speaking of the nerve supply of the internal oblique, "The main branches of

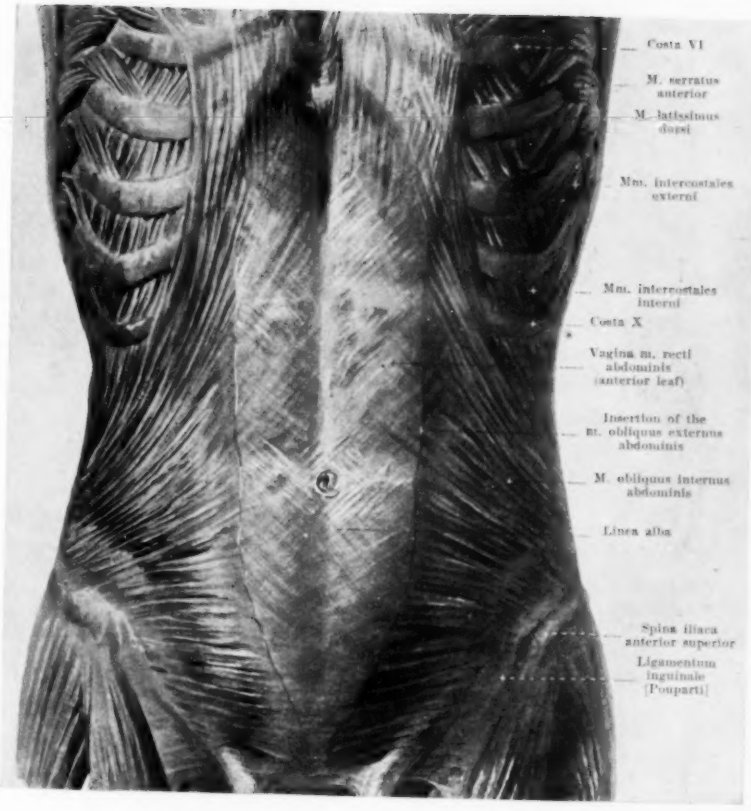

FIG. 10.—Plate from Spalteholz's Anatomy, showing the short transverse fibres at the lower part of the internal oblique muscle.

these nerves run forwards between this muscle and the transversalis abdominis, and give off their filaments to the internal surface of the muscle; some also are distributed to the muscle by the branches which perforate it in order to supply the external oblique."

3. During hernia operations he had carefully inspected the nerve through a large lens, and, on lifting it up with the forceps, had seen little filaments branching from the nerve.

4. He had cut out from the cadaver long strips of muscle in which the nerve lay and had dissected them out under dilute nitric acid solution on an illuminated stage and under a large lens, and had, in this way, seen similar nerve filaments branching from the main trunk of the nerve.

5. He had had serial microscopic transverse sections made of the muscle strip containing the nerve, and in these sections had distinguished small nerve filaments which were distinct from the main trunk.

6. He had stimulated this nerve by separating its distal portion and laying it over a piece of gauze, or a piece of rubber tissue, and, using a Faradic needle at the time of operation, had regularly obtained localized contractions of this part of the muscle.

This series of reasons are so definite that he believed them to be much more valuable than experiments on the anterior roots of dogs.

Men have walked on two legs for thousands of years and dogs have walked on four legs for a similar period, and hence have not had the same strain on the lower fibres of the abdominal muscles. Degenerative changes in dogs' nerves are not as convincing as the facts which he had observed in men's muscles and nerves.

Possibly Dr. Moschcowitz and he were thinking of different things when they spoke of injury to this nerve during operation. When he first called attention to the subject, he had recently gone through a period of several years with seven house surgeons, yearly, scattered through different institutions. Their previous training had been diverse, and hence showed much about prevalent methods of hernia operation.

The following methods of nerve injury may be noted: (1) Forcibly scraping the internal oblique with scissors in clearing the way to Poupart's ligament, and tearing the nerve from its bed in so doing. (2) Lifting the nerve from its bed with forceps and carrying it upward "out of harm's way." This, of course, tears away all the fibres which branch from it in this area. (3) Splitting the external oblique aponeurosis from below, through the external ring, and dividing the nerve in so doing. (4) Dividing it or including it in a suture just before its entrance into the external oblique aponeurosis.

The last is probably the least harmful of these procedures, because it injures the nerve beyond the place where most, or perhaps all, of the motor fibres have been given off. But there is a trophic function beyond this point. The trophic function exists in the sensory as well as in the motor parts of nerves. It is believed to come from the sympathetic system, the fibres of which enter the nerve distal to the anterior nerve roots.

An example of the trophic function in the motor part of nerves is shown when a cut of the median nerve in the palm or at the wrist is accompanied by trophic disturbance in the fingers, although the motor portion of the nerve which controls the fingers is not injured by this cut. Now this iliohypogastric nerve enters the aponeurosis of the internal oblique just above the external ring, and he was entirely willing to concede that at that point most of the fibres are sensory, but he was not at all willing to concede that they have lost their trophic function, and he thoroughly believed that a certain portion of the atrophic function affects the fibrous structures of the external oblique aponeurosis into which the nerve runs, and this aponeurosis is important in preventing direct hernia—a form which is most common in recurrences. Therefore, even the division or injury of the terminal part of the nerve at its entrance into the external oblique aponeurosis has a certain effect upon the strength of the structures which protect Hesselbach's triangle.

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